.53
578
Illinois U Library

PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

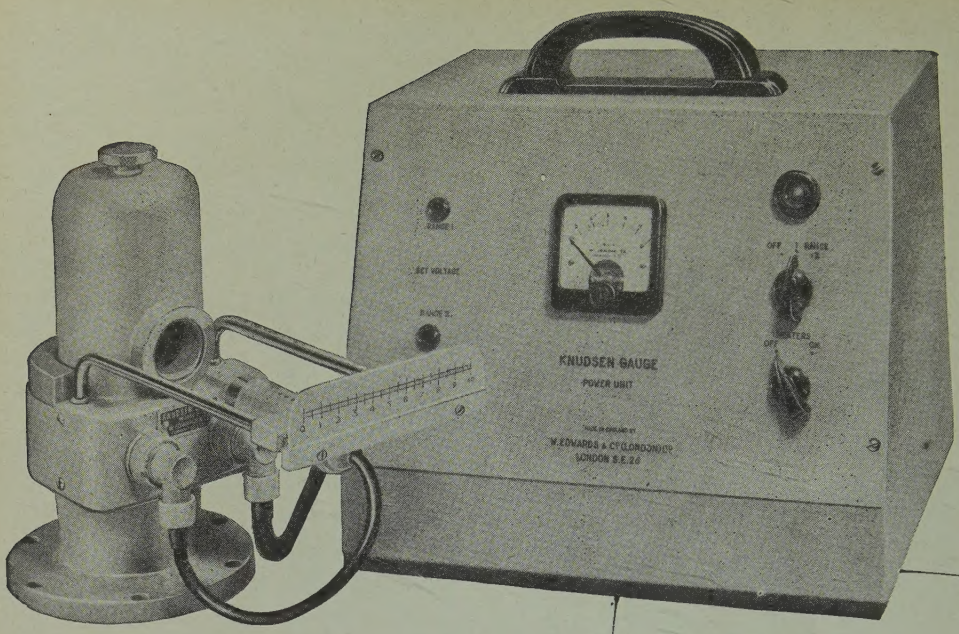
THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

ABSTRACTS 5827–6371

VOLUME 56 **SEPTEMBER 1953** NUMBER 669



The ONLY High Vacuum Gauge Measuring TRUE Gas Pressures, Vapours and Mixtures.

- ★ NO DELICATE FILAMENT TO BURN OUT
- ★ FREE FROM DECOMPOSITION, GETTERING, IONISATION AND CONTAMINATION ERRORS
- ★ ROBUST SUSPENSION SYSTEM FREE FROM VIBRATION SENSITIVITY
- ★ DEMOUNTABLE 'HIGH SPEED' VACUUM CONNECTION WITHOUT SPECIAL SUPPORT
- ★ STABILISED MAINS-OPERATED CONTROL UNIT

EDWARDS KNUDSEN HIGH VACUUM GAUGE

RANGE: 10^{-4} to 10^{-7} mm Hg.

The fragility and vibration sensitiveness of previous models of the Knudsen gauge have limited its usefulness to rare cases in the research laboratory. NOW, for the first time, this EDWARDS robust, but precision instrument for general laboratory and industrial use, is available.

Send for complete details of the MODEL N.I

for better vacuum service... **W. EDWARDS**
& CO., (LONDON) LTD.
LOWER SYDENHAM, LONDON. S.E.26.

TELEPHONE: SYDENHAM 7026 (8 LINES) TELEGRAMS: EDCOHIVAC, SOUPHONE, LONDON

Principal Contents

SEPTEMBER 1953

		PAGE
51	MATHEMATICS	751
52	ASTRONOMY. ASTROPHYSICS. GEODESY	751
53	PHYSICS	753
530.1	Fundamentals	753
531	General mechanics. Mechanics of solids	756
531.7	Mechanical measurements	756
532	Mechanics of fluids	756
532.6	Capillarity	759
532.7	Molecular theory of liquids	760
533	Mechanics of gases	760
533.7	Molecular theory of gases	761
534	Vibrations. Acoustics	761
535	Optics. Radiation. Spectra	766
536	Heat	772
536.7/.8	Thermodynamics	775
537	Electricity	777
537.1	Theory. Electrons	—
537.2	Electrostatics. Dielectrics	777
537.3	Electric conduction. Currents	777
537.52	Electric discharges	781
537.531	X-rays	782
537.533/.534	Cathode rays. Positive rays	783
537.54	Discharge tubes. Counters	787
537.56/.58	Ionization. Thermionics	788
537.591	Cosmic rays	789
538	Magnetism	790
538.3/.5	Electromagnetism. Electrodynamics	792
538.56	Electromagnetic waves and oscillators	793
538.6	Magnetic effects	794
539.1	Molecular and atomic structure	794
539.11	Theory of solid state	794
539.13	Molecular structure	794
539.15	Atomic structure. Nucleus. Isotopes	795
539.16	Radioactivity. α-, β- and γ-rays	797
539.17	Nuclear reactions	800
539.18	Atom and molecular beams. Mesons. Neutrons	802
539.2	Structure of solids	803
539.3/.8	Elasticity. Strength. Rheology	805
541	PHYSICAL CHEMISTRY	808
541.11/.12	Phase equilibrium. Chemical reactions	808
541.13	Electrochemistry	809
541.14/.15	Photochemistry. Radiation chemistry	810
541.18	Dispersions. Colloids. Adsorption	811
541.2/.6	Chemical structure	811
542.1/.7	Laboratory apparatus	—
542.9	Chemical processes	—
543/545	Chemical analysis	—
548	CRYSTALLOGRAPHY	812
548.7	Molecular and X-ray crystallography	812
55	GEOPHYSICS	815
551.5	Atmosphere. Meteorology	815
57/59	BIOLOGY	816
61	Medical science. Human physiology	816
66/67	TECHNICAL MATERIALS	818
77	PHOTOGRAPHY	818

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953). Reprints of the List of Journals can be obtained from the Institution of Electrical Engineers, Savoy Place, London W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Ann. Meteorol.	*Annalen der Meteorologie.* [Abstracted by *Meteorological Abstracts.*]
Arch. Meteorol. Geophys. und Bioklimatol. A	*Archiv fur Meteorologie, Geophysik und Bioklimatologie, Serie A* [Abstracted by *Meteorological Abstracts.*]
Euclides [*Madrid*]	*Euclides* [*Madrid*]. [Abstracted by *Meteorological Abstracts.*]
J. Geomagn. Geoelect.	*Journal of Geomagnetism and Geoelectricity.* Society of Terrestrial Magnetism and Electricity of Japan. Geophysical Institute, Kyoto University, Kyoto.
J. Japan Soc. Appl. Mech.	*Journal of the Japan Society of Applied Mechanics.* Post Restant, Box No. 24, Shibuya Post Office, Tokyo.
J. Mech. Phys. Solids	*Journal of the Mechanics and Physics of Solids.* Pergamon Press, 242 Marylebone Road, London, N.W.1.
J. Polymer Sci.	*Journal of Polymer Science.* [Abstracted by Metropolitan-Vickers Electrical Co.]
J. S. African Chem. Inst.	*Journal of the South African Chemical Institute.* [Abstracted by *Nuclear Science Abstracts.*]
J. sci. Météorol.	*Journal Scientifique de la Météorologie.* [Abstracted by *Meteorological Abstracts.*]
Mem. Fac. Technol. Tokyo Metrop. Univ.	*Memoirs of the Faculty of Technology. Tokyo Metropolitan University.* Tokyo.
Mod. Transport	*Modern Transport.* [Abstracted by Metropolitan-Vickers Electrical Co.]
Rep. Ionosphere Res. Japan	*Report of Ionosphere Research in Japan.* The Maruzen Publishing Company, Tokyo.
Weld. Res.	*Welding Research.* [Abstracted by Metropolitan-Vickers Electrical Co.]

New Journals

Doshisha Engng Rev. Special Pap.	*Doshisha Engineering Review Special Papers.* Doshisha Kogaku-Kai [Doshisha University Engineering Association], Kyoto. No. 1 dated July, 1952.
Bull. Acad. Polon. Sci. Cl. 3	*Bulletin de l'Académie Polonaise des Sciences, Classe Troisième:* Mathématique, Astronomie, Physique, Chimie, Géologie et Géographie. Polska Akademia Nauk, ul. Nowy Świat 72, Warsaw. Vol. 1, No. 1 dated 1953.

Notes

Acta Physica Polonica	Address changed to: Polska Akademia Nauk, ul. Nowy Świat 72, Warsaw.
Akustische Beihefte	Pagination of 1953 issues is that of Volume 3, 1953, of *Acustica.*
Atomics and Atomic Technology	Stratford House, 9 Eden Street, London, N.W.1. Extension of title as from issue of June, 1953, and correction to address published in the List of Journals, January, 1953.
British Standards	Address changed to: British Standards Institution, 2 Park Street, London, W.1.
Geophysics	Address changed to: 624 South Cheyenne, Tulsa 3, Oklahoma.

Transactions of the Institute of Metal Finishing [incorporating Electrodepositors' Technical Society]. Continuation of the *Journal of the Electrodepositors' Technical Society.* Address unchanged.

Errata

Abstr. 8399 (1952) line 4: *for* **24** *read* **25.**

Abstr. 3775 (1953) line 3: *for* **44** *read* **55.**

Abstr. 3854 (1953) line 12: *for* "provided that a" *read* "and that no"

Abstr. 3915 (1953) line 5: *for* Everard *read* Euverard;
for (1944) *read* (1949).

MATHEMATICS 51

512.3

5827. On the standard errors in the fitting of polynomials to unequally spaced observations. P. G. GUEST. *Austral. J. Phys.*, **6**, 131–54 (*June*, 1953).

See also Abstr. 6980 (1952). From the observed values of the independent variable two parameters are derived which specify the departure from uniform spacing. Expressions are obtained for the standard errors of the coefficients and fitted values in terms of these parameters, and numerical tables for the estimation of the errors are given. It is shown that the errors calculated in this way lie within a few per cent of the exact least squares values for polynomials of the first and second degree, but when the polynomial is of the third degree the deviations may be much greater. A.

518.2

5828. A short table for the Bessel functions $I_{n+\frac{1}{2}}(x)$, $(2/\pi)K_{n+\frac{1}{2}}(x)$. C. W. JONES. *Cambridge: University Press* (1952) 20 *pp.*

Review in *J. chem. Phys.*, **21**, 1120 (*June*, 1953). This pamphlet gives the functions to 7 or 8 figures in the ranges $x = 0(0\cdot1)10$, $n = 0(1)10$, with full provision for interpolation and extension of the range of x. It is published for the Royal Society Committee on Mathematical Tables.

518.3 : 539.172.4

5829. Nomograms used in analysis of data in the reaction $Li^6(n, \alpha)H^3$. M. L. BOAS. *Rev. sci. Instrum.*, **24**, 356–9 (*May*, 1953).

Several nomograms and similar computational devices have been found useful in the analysis and interpretation of data from the reaction $Li^6(n, \alpha)H^3$ in photographic emulsions. Three of these are discussed here: (1) a slide rule to determine from measurements on a track with the triton in a small forward cone, what the track length would have been if the triton had gone exactly forward; (2) a nomogram to determine the true α-triton angle from its measured projection in the plane of the emulsion; (3) a device for determining, from measurements on a track, the angle between the emulsion and the incident neutron giving rise to the track. A.

518.4

5830. Calculation of accuracy of results of graphical square intercomparisons. P. M. GILET AND G. S. WATSON. *Austral. J. Phys.*, **6**, 155–70 (*June*, 1953).

Graphical squares of two types are used for calculating the results of intercomparisons of standards of length, mass and other quantities, and the results of calibration of scales. By means of graphical squares, estimates of the true values or "improved" values are obtained from observations. From the differences between the improved and observed values, the residuals, a measure of the accuracy of the intercomparison, may be obtained. In this paper expressions are derived which enable the calculation, from the residuals, of accuracies of observed values, of improved values and of various quantities derived from the improved values. A.

518.5 : 536.71

Equation of state calculations by fast computing machines. *See Abstr.* 6026

518.5 : 621.318.042.14 : 621.318.572

5831. Magnetic storage units with short call-up times for electronic calculating machines. H. BILLING. Note in *Naturwissenschaften*, **40**, *No.* 2, 49–50 (1953) *In German.*

Describes storage units employing small anchorring cores made from ferrite material having a hysteresis loop in the form of a parallelogram. Call-up times of about 5×10^{-6} sec are attainable.

E. P. WOHLFARTH

519.2

5832. Recurrence and first passage times. M. S. BARTLETT. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 2, 263–75 (1953).

The problem studied is the probable time of recurrence of a given state of a physical system. Attention is confined to homogeneous processes. The probability problem is first formulated in symbolic terms, and attention is concentrated on general structural relations and not specific points of rigour or applications. Ergodic properties of renewal processes and Markoff processes are studied, and recurrence distributions for finite Markoff chains are discussed. L. S. GODDARD

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.615

5833. A device for the transformation of calibration curves of photoelectric plate photometers. K. BAHNER AND G. R. MICZAIKA. *Z. Astrophys.*, **32**, *No.* 1, 64–8 (1953) *In German.*

Photometric calibration curves can be transformed within a wide range of values with this new electronic instrument, which is an adaptation of the design by DeWitt and Seyfert [*Publ. Astron. Soc. Pacific*, **62**, 241 (1950)]. Its special applicability to spectrophotometry is emphasized, where it is often desirable to obtain some particularly suitable relationship between intensity and measured deflection, and also increased values of sensitivity, while keeping a suitable zero (e.g. in the recording of faint absorption lines in heavily exposed spectra). The instrument is used in conjunction with the Zeiss recording photometer of the Heidelberg Observatory. A. BEER

523.11 : 523.852.32

5834. Contribution to the turbulence theory of spiral nebulae. S. v. HOERNER. *Z. Astrophys.*, **32**, *No.* 1, 51–8 (1953) *In German.*

An estimate of radial distribution of surface density can be obtained from v. Weizsäcker's theory of the evolution of a rotating gas. An estimate can also be obtained from the observed shapes of spiral arms by application of the Heisenberg–Weizsäcker theory (1948). These two estimates are found to be in qualitative agreement, and to agree also with observed distribution of surface brightness. R. A. NEWING

523.11 : 530.12

On the possibility of a new static cosmological model. *See Abstr.* 5848

523.59

5835. An examination of the zodiacal light and gegenschein from photoelectric measurements at the Jungfraujoch. A. BEHR AND H. SIEDENTOPF. *Z. Astrophys.*, **32**, *No.* 1, 19–50 (1953) *In German.*

The brightness and polarization of the evening zodiacal light and gegenschein has been recorded in blue and yellow light using a photo-multiplier (1P21) and tuned amplifier, in conjunction with colour-filters and a rotating "Polaroid" analyser. The polarized component of the Z.L. exhibits a symmetrical elliptical intensity distribution with respect to the ecliptic, the isophotic axes having ratio 2 : 1. The unpolarized component shows marked asymmetry, with a strong concentration along the ecliptic. The surface brightness of the gegenschein exceeds the sky background by an amount equal to *c.* 30×10 mag. stars/sq. degree. The observed zodiacal polarization (19% at 60° from ⊙) is supposed due to free electrons, the dust component of the zodiacal matter causing inappreciable polarization, the particle radii being $> 10^{-4}$ cm. D. R. BARBER

523.59

5836. Photoelectric observations of the zodiacal light. H. SIEDENTOPF, A. BEHR AND H. ELSÄSSER. Letter in *Nature* [*London*] **171**, 1066–7 (*June* 13, 1953).

Records of brightness and polarization of the zodiacal light were obtained with a 1-P 21-multiplier (preceding abstract) during Feb.–Mar. and Oct., 1952, and in the winter, 1952–53, on the Jungfraujoch (3600 m). Spatial densities of electrons and dust particles were deduced from these results on the basis of Mie scattering theory. Electron distribution is symmetric, and dust distribution asymmetric, with respect to the ecliptic; the observed densities of electrons and dust-particles near the earth's orbit being $\sim$600 per cm^3, and $\sim 10^{-23}$ g/cm^{-3} respectively. Brightness of gegenschein corresponds to that of a dust cloud, 20° dia., distant 0·01 A.U. from earth. D. R. BARBER

523.746

5837. The radial distribution of magnetic field strength in normal sunspots. W. MATTIG. *Z. Astrophys.*, **31**, *No.* 4, 273–81 (1953) *In German.*

Extensive observations of Zeeman splittings of the line Fe 6302·51 Å, obtained at the Einstein Tower of the Potsdam Observatory on 10 sunspots in 1948–50, cover the magnetic field strength H at a number of distances r from the centre of the spot up to the outer border of the penumbra (distance b). Here the field strength reaches zero, i.e. the optical and the "magnetic" diameters of the sunspots coincide. Broxon gave the formula $H = H_m(1 - r^2/b^2)$, where H_m is the maximum field strength at the spot centre. Mattig now shows that this formula should be replaced by $H = H_m[1 - (r^2/b^4)]e^{-2(r/b)^2}$, which is a good empirical fit for the new Potsdam data, and confirms the discordance between Broxon's formula and observation, found earlier by von Klüber [Abstr. 1404 (1948)]. A. BEER

523.746

5838. The magnetic field strength in sunspots. G. THIESSEN. Note in *Naturwissenschaften*, **40**, *No.* 7, 218–19 (1953) *In German.*

The overlapping of the components of a Zeeman triplet in a sunspot spectrum produces a shift in the centres of gravity of the outer components which simulates a small magnetic field. This has been neglected by Mattig (preceding abstract), whose formulae for field strength and induction are thus less in accord with observation than the earlier formulae of Broxon (1942) and Chapman (1943). M. W. OVENDEN

523.755

5839. The effect of interstellar polarization in the solar corona. G. THIESSEN. Note in *Naturwissenschaften*, **40**, *No.* 1, 17 (1953) *In German.*

Öhman's measurements of the polarization in the *F*-corona during the eclipse of July 7, 1945 [Abstr. 2008 (1947)], are compared with three recent theories on the possible origin of interstellar polarization. While no definite decision in preference of one of these views can be made in the case of the available stellar observations, Thiessen states that for the corona results he finds such a discrimination possible, and decides in favour of the theory put forward by Davis and Greenstein [Abstr. 1396 (1952)]. Indirectly this conclusion appears to furnish an independent proof of the existence of a general magnetic field of the sun. A. BEER

523.775

5840. Monochromatic fluctuations of the inner solar corona. W. PETRI. *Z. Astrophys.*, **31**, *No.* 3, 195–206 (1952) *In German.*

Based on daily visual measures of coronal line-intensity at wavelengths 5303 Å (Fe XIV) and 6374 Å (Fe X), a study of diurnal latitude distribution of the two monochromatic fluxes within +45° to −45° heliographic latitude reveals fluctuations of intensity which are most marked in both N. and S. zones in latitude $\sim$15° higher than that of the equatorial region of main coronal activity, the altitude of the disturbances being *c.* 24,000 km. Two distinct latitude effects on the variations of (i) electron density, and (ii) electron temperature are found also. D. R. BARBER

523.823

5841. Determination of stellar diameters from the diffraction of light-rays at star-occultations. H. DIERCKS AND K. HUNGER. *Z. Astrophys.*, **31**, *No.* 2, 181–93 (1952) *In German.*

A theoretical discussion of the possibility of measuring the diameter of a star occulted by the moon, based

on observing its diffraction pattern at occultation as suggested first by Williams (1938). D. R. BARBER

523.823

5842. The colour-luminosity diagram for the Coma Berenices star cluster. K. BAHNER AND G. R. MICZAIKA. *Z. Astrophys.*, **31**, *No.* 3, 236–48 (1952) *In German.*

Photoelectric magnitudes and colour indices have been measured for 39 stars of the cluster with a photomultiplier tube (R.C.A. 1P21) attached to the 32 cm Heidelberg refractor. Mean probable errors of $\pm 0^m \cdot 005$ in colour index, and $0^m \cdot 007$ in magnitude are found. D. R. BARBER

523.823

5843. Separation of giant and dwarf stars by means of 3-colour photometry. W. BECKER. *Z. Astrophys.*, **31**, *No.* 3, 249–55 (1952) *In German.*

Photographic filter photometry has been used to determine magnitude measures at wavelengths 3730, 4700 and 6380 Å for giants and dwarfs of spectral classes, G, K in Selected Areas 17, 40 and 42. Colorometric identification of the two types is based on the magnitude differences: $^m3730 - {}^m4700$ and $^m4700 - {}^m6380$. Colour indices are tabulated for 62 selected stars in area 17; 32 stars in area 40; and 32 stars in area 42. D. R. BARBER

523.877

5844. The "homologous" rule in the theory of stellar constitution. R. KURTH. *Z. Astrophys.*, **32**, *No.* 1, 11–18 (1953) *In German.*

If two stellar models are expressed mathematically by a series of basic equations involving dimensionless quantities, the models are termed "homologous" when these quantities are identical for each model. Thus the "homologous" rule for two different stars follows from an exact equality of their dimensionless parameters. Using the mass-luminosity and mass-radius relations, the "homologous" rule is used to define the class-grouping of main-sequence stars. D. R. BARBER

PHYSICS 53

FUNDAMENTALS 530.1

530.12

5845. The formulation of the laws of conservation of energy and momentum in the general theory of relativity. II. M. KOHLER. *Z. Phys.*, **134**, *No.* 3, 286–305 (1953) *In German.*

For Pt I, see Abstr. 5516 (1952). Field equations which are expressed in terms of two metric tensors are derived from a modified Hamiltonian function, variation being taken both with respect to the g_{ik} and the $\bar{g}_{ik}$, the latter providing a set of conditions equivalent to the vanishing of the divergence of the matter tensor. The new theory is compared in detail with classical general theory, and is found to provide the same observational results. R. A. NEWING

530.12

5846. On the derivation of the field equations in the general relativistic theory of gravitation. M. KOHLER. *Z. Phys.*, **134**, *No.* 3, 306–16 (1953) *In German.*

Continuing an earlier paper (preceding abstract) a generalized Hamiltonian function is deduced from certain general requirements and is found to depend upon two parameters, one of which may be eliminated by the further requirement that weak fields shall approximate to Newtonian fields. The remaining parameter λ may be evaluated either from observed planetary motion or from the deflection of light in a gravitational field. Observed results are given for $\lambda = 1$, and in this case the Hamiltonian reduces to that introduced in the paper referred to. R. A. NEWING

530.12

5847. The continuum in special relativity. II. B. LEAF. *Phys. Rev.*, **90**, 1090–101 (*June* 15, 1953).

For Pt I, see Abstr. 55 (1952). A covariant description is given of the properties, relative to an arbitrary secondary frame, of an element of anisotropic continuum composed of a single chemical species. These properties are measured by an observer in a primary reference frame relative to which the motion of the secondary frame is constant. This is a generalization of an earlier formalism in which the secondary frame coincided with the rest frame of the element. The equation of continuity of mass in the classical sense is formulated, and Gauss's theorem for transformation of volume integrals of space divergences into surface integrals is stated for the secondary reference frame. If the equation of motion relative to the secondary frame is assumed given by the statement that the divergence in the secondary frame of the energy-momentum tensor vanishes, then the equation for the first law of thermodynamics, the equation of continuity of energy, the dynamical equations of motion including the force equation and the kinetic energy equation, and the equation of continuity of momentum result; each equation is formulated for motion of an element of continuum relative to an arbitrary secondary frame as measured by a primary observer. The divergence in the secondary frame of the entropy tensor is assumed to be a time vector whose projection upon the four-vector velocity of the element relative to the primary frame is non-negative; this is shown to imply the second law of thermodynamics relative to the secondary frame, and, in the reversible case, an equation of continuity of entropy. The equation defining the reversible stress in the element of continuum is introduced. The chemical potential function which appears in this equation has the properties of the specific Helmholtz free energy in the thermodynamic consequences of this equation and the properties of the specific Gibbs free energy in the dynamical consequences, a circumstance which obviates the necessity of formulating a Gibbs free energy for anisotropic media. The conditions for reversibility of a process in the continuum are found to be independent of the secondary reference frame

chosen for description of the process. Finally, a covariant theory of transport processes is given for a one-component, anisotropic medium. It is shown that in the theory of diffusion and thermal conduction the motion of every element of the continuum must satisfy a special transport condition relative to a secondary frame; in the theory of viscosity this condition need not be met. A.

530.12 : 523.11

5848. On the possibility of a new static cosmological model. R. L. BRAHMACHARY. Note in *Naturwissenschaften*, **40**, *No.* 2, 51 (1953) *In French.*

The general form of the line element is derived for models in which $T_1^1 \neq T_2^2$, such models being interpreted physically in terms of an electrified substratum.

R. A. NEWING

530.145

5849. Derivation of quantum theory from a classical causally determined model. W. WEIZEL. *Z. Phys.*, **134**, *No.* 3, 264–85 (1953) *In German.*

Following up the ideas of Bohm [Abstr. 2413–14 (1952)] and Fenyes [Abstr. 5523 (1952)] on the "causal" interpretation of wave mechanics, it is shown that both the continuity equation and the equation of motion containing the additional "quantum-mechanical" potential can be derived as the statistical equations corresponding to a particular classical diffusion model. Apart from the influence of the external field, the particles are also assumed to be subject to a constant number of intermittent impulses which are independent of the motion of the particles and do not change their average momentum. Zero-point fields and neutrinos are mentioned in connection with speculations on the nature and origin of these hypothetical impulses. W. A. HEPNER

530.145

5850. The penetration through a potential barrier of a particle with spin ½ in the case of scalar interaction. P. E. KUNIN AND I. M. TAKSAR. *Latv. PSR Zināt. Akad. Vēstis*, **1951**, *No.* 10, 1633–8. *In Russian.*

It is shown that in this case "Klein's paradox" does not arise. The penetration of a particle into a sufficiently large negative potential is also found to be impossible. W. J. SWIATECKI

530.145

5851. On the description of bound states in field theory. W. GLASER AND W. ZIMMERMANN. *Z. Phys.*, **134**, *No.* 3, 346–62 (1953) *In German.*

The analogy between the integral equation for a solution of the Dirac equation with an external potential and that for the state vector in the interaction representation of field theory is used to characterize bound states in field theory as the solutions of the homogeneous integral equation. This holds true also for many-particle problems if at least one of the particles is bound to the potential. The consequences from this definition of bound states include certain properties of the transformation operator linking the state vector at different times.

W. A. HEPNER

530.145

5852. The number of stable states of a particle with spin ½ in a central field with a pole of high order. P. E. KUNIN AND I. M. TAKSAR. *Latv. PSR Zinā Akad. Vēstis*, **1951**, *No.* 11, 1775–7. *In Russian.*

From the behaviour for $r \to 0$ of the solutions Dirac's relativistic equation with a scalar potential the type $-r^{-n}$ $(n > 2)$, it is concluded that the partic does not fall into the singularity. The opposite is th case for a vector potential or a non-relativistic trea ment. W. J. SWIATEC

530.14

5853. The exchange potential in an electron gas a nonzero temperature. H. ZIRIN. *Phys. Rev.*, **90** 795 (*June* 1, 1953).

The Dirac calculations for the exchange potentia acting on an electron in a uniform Thomas–Ferm cloud of other electrons has been extended from th low temperature to the high temperature limit Expressions are given for this exchange potential ove the whole temperature range. A

530.14

5854. The use of the Tamm–Dancoff method in field theory. F. J. DYSON. Letter in *Phys. Rev.*, **90**, 99 (*June* 1, 1953).

For a state ψ of interacting fields (ψ_0 the true vacuum state) amplitudes $(\psi_0^* C(N')A(N)\psi)$ are define $(C(N'), A(N)$ being products of creation and annihila tion operators resp.) which satisfy integral equations analogous to the Tamm–Dancoff equations. How ever, in contrast to the latter, these are free from divergences of the vacuum self-energy type and contain only the observed energy of state ψ.

R. H. DALITZ

530.145

5855. The Tamm–Dancoff formalism and the symmetric pseudoscalar theory of nuclear forces. A. KLEIN. *Phys. Rev.*, **90**, 1101–15 (*June* 15, 1953).

The general method of deducing the Tamm–Dancoff equal-times formalism, as generalized by Lévy, from the relativistic two-body equation of Bethe–Salpeter and Schwinger is given. Only processes which are finite *ab initio* are considered. The essence of the procedure is the relation between a set of conventional matrix elements of the Tamm–Dancoff formalism and the Feynman diagram which summarizes them; this relationship provides a convenient guide for enumerating all matrix elements of a specified type and precludes the possibility of omission of any members of the set. Rules are also given for writing down any matrix element. The method is then applied to the derivation of the fourth-, sixth- and eighth-order adiabatic potentials on the symmetrical pseudoscalar-pseudoscalar theory. Some discrepancies with the results of Lévy are noted in connection with the fourth-order potential. These are: first, that a more careful treatment of the energy denominators of the leading two-pair terms brings to light contributions that cancel with all other two-pair matrix elements that are of relative order μ/M compared to the leading ones; second, that the one-pair terms do not vanish but yield a repulsive interaction which substantially alters the qualitative picture of the fourth-order potential; third, that for the no-pair terms the result should agree with the previously calculated fourth-order potential for the pseudoscalar-pseudovector theory. The sixth- and eighth-order results are also in disagreement with

Lévy. Finally, an analysis of the problem of many-particle forces is given and explicit results obtained for the leading terms of the three- and four-particle forces as well as for certain smaller contributions to the three-particle interaction. A.

530.145

5856. On the asymptotic description of scattering processes. K. O. FRIEDRICHS. *Nachr. Akad. Wiss. Göttingen, Math.-phys. Kl. IIa*, **1952**, *No.* 7, 43–50. *In German.*

An expression for the transition probability is derived on the assumption that the momentum in the initial state is only approximately "sharp." This expression increases nearly linearly during a time interval related to the width of the initial energy interval by the uncertainty relation. It is shown that, in the limit of infinitely long time, this expression tends to that obtained from Heisenberg's *S*-matrix theory. W. A. HEPNER

530.145

5857. The elastic scattering of pions in deuterium. K. A. BRUECKNER. Letter in *Phys. Rev.*, **90**, 715 (*May* 15, 1953).

The inclusion in the method of Abstr. 2206 (1953) of multiple scattering by the 2 nucleons in the *d* leads to an improved fit of the impulse approximation calculations with the experiments of Arase *et al.* (1953). W. J. SWIATECKI

530.145

5858. Recoil effects in meson-nucleon scattering. E. M. HENLEY AND M. A. RUDERMAN. Letter in *Phys. Rev.*, **90**, 719 (*May* 15, 1953).

In connection with the observed asymmetry about 90°, the *S* and *D* phases were calculated for ps.scalar mesons coupled by means of a term $\sum_1^3 g\tau_j\sigma\,.\,(\nabla\phi_j - iV\pi_j)$. The term $\sigma\,.\,V$, where $V =$ average nucleon velocity, ensures invariance under Galilean transformation. [R. P. Feynman, Rochester Conference (1952)]. W. J. SWIATECKI

530.145

5859. Fourth-order corrections to the scattering of pions by nonrelativistic nucleons. J. S. BLAIR AND G. F. CHEW. *Phys. Rev.*, **90**, 1065–7 (*June* 15, 1953).

Fourth-order corrections to the field theoretical phase shifts for pion nucleon scattering have been calculated for a linear and extended coupling and no nucleon recoil. The results support the use of the "Dancoff approximation," since those processes passing through intermediate states which contain three pions turn out to be much less important than processes involving only one and two pions. A.

530.145

5860. A note on meson-nucleon scattering. R. KARPLUS, M. KIVELSON AND P. C. MARTIN. *Phys. Rev.*, **90**, 1072–5 (*June* 15, 1953).

A relativistic meson–nucleon two-body equation applicable to the elastic non-exchange scattering of negative pions by protons is solved using the lowest order interaction kernel. The scattering matrix which this equation yields is shown to be unitary. The total cross-section calculated from this scattering matrix is finite at threshold and relatively independent of the coupling constant. A plot of the cross-section as a function of energy is included. A.

530.145

5861. A covariant meson-nucleon equation. S. DESER AND P. C. MARTIN. *Phys. Rev.*, **90**, 1075–8 (*June* 15, 1953).

A relativistic meson-nucleon two-body equation is derived in a form suitable for carrying out renormalization. Methods for determining the interaction kernel and classifying its terms are discussed. A reduction of the equation to three dimensions is carried out and the approximations involved in this procedure are examined. The resulting equation agrees with a corresponding one derived by Tamm–Dancoff methods. A.

530.145

5862. Two-electron self-consistent field. A. O. WILLIAMS, JR. *Phys. Rev.*, **90**, 803–7 (*June* 1, 1953).

Stevenson's extension of the Hartree self-consistent field (s.c.f.) method, to take some account of polarization interaction between two outer electrons, is worked out numerically, up to a point, for H^-. The two-electron wave function is a product of two one-electron radial functions and a function X of the angle between the two radii. Several integrals must be calculated and a boundary value problem for X must be solved prior to the stage of ordinary Hartree calculations. These fundamental computations are made here, but the routine solution of the radial Hartree equations has been omitted; instead the Stevenson corrections to the total energy are estimated by perturbation methods. These corrections seem just about large enough to yield an electron affinity for H^- (something not achieved by s.c.f. or variation methods without polarization). However, a good deal of labour is involved beyond that required for s.c.f. solutions, and it is not certain that this particular method of including polarization effects is to be preferred to a combination of variation and s.c.f. calculations. A.

530.145

5863. Pseudoscalar interaction in the theory of beta-decay. II. T. AHRENS. *Phys. Rev.*, **90**, 974–7 (*June* 1, 1953).

For Pt I, see Abstr. 7953 (1952). It is shown that analysis of the pseudoscalar interaction in β-decay theory results in the appearance of the two sets of nuclear matrix elements, $\int \theta_p\beta\gamma_5$ and $(i/2M)\int \theta_p\sigma.\{\nabla\}$, θ_p denoting the angular part of the pseudoscalar lepton covariant and $\{\nabla\}$ the gradient operation on the radial part of this covariant, instead of the single matrix element, $\int \theta_p\gamma_5$. As a consequence pseudoscalar interaction correction factors containing derivatives of the lepton wave functions are deduced. A.

530.145

5864. Production of polarized particles in nuclear reactions. A. SIMON AND T. A. WELTON. *Phys. Rev.*, **90**, 1036–43 (*June* 15, 1953).

A general calculation of the polarization resulting from nuclear reactions is made by means of the *S*-matrix and Racah formalisms. All sums over magnetic quantum numbers are performed; and the resulting polarization is expressed as a series in associated Legendre polynomials, each coefficient being manifestly real. All selection rules follow immediately from the requirements for the non-

vanishing of the Racah and X coefficients. The only restriction required is to a two-body break-up. Higher spin tensor moments are required for the complete specification of the state of polarization of a beam of particles of spin greater than $\frac{1}{2}$. A general expression is given for arbitrary spin moments resulting from a nuclear reaction. The result is expressed as a series in the spherical harmonics with all coefficients being manifestly real. The previous results of Blatt and Biedenharn [Abstr. 1100 (1953)] for the angular distribution follow as a special case of the result. A generalization of the Eisner–Sachs rules for the complexity of angular distributions is also given. A.

530.145

5865. Electrical models of the wave equation of quantum mechanics. (Investigation of potential barriers.) E. R. MUSTEL'. *Zh. tekh. Fiz.*, **22**, *No.* 3, 369–80 (1952) *In Russian.*

Models were constructed of chains of discrete electrical cells, each with 1 vibrational degree of freedom. Under certain boundary conditions the equations for potentials and currents go over into differential equations analogous to the wave equation with variable coeffs. Here current, electric potential and square of eigenfrequency of the elementary cell correspond in turn to the wave function, its derivative and the potential energy. The scheme allowed potential barriers of any shape to be represented, of which 2 were examined: the rectangular barrier, for which an exact analytical solution exists, and the form $U(x) = U_0/ch^2\alpha x$, for which the solution requires non-tabulated hypergeometric functions. Since the agreement of electric model and analytic solution is to within 5% for the rectangular case, it is suggested that the 2nd case may serve as a "tabulation" of the required hypergeometric functions. J. JACOBS

530.145

5866. Momentum space wave functions. II. The deuteron ground state. E. E. SALPETER AND J. S. GOLDSTEIN. *Phys. Rev.*, **90**, 983–6 (*June* 1, 1953).

Previously [Abstr. 1477 (1952)] a procedure was given for carrying out numerically an iteration method to get approximate solutions for wave functions in momentum space and for eigenvalues. This procedure is applied to the ground state of the deuteron in non-relativistic approximation, using central potentials only. Tables illustrating the rapidity of convergence of the iterations are given. Values for the momentum space wave functions corresponding to different potential shapes are tabulated, and simple analytic approximations are given. A.

530.162

5867. Stochastic dependence character of Heisenberg's uncertainty relation. I. FÉNYES. Note in *Naturwissenschaften*, **39**, *No.* 24, 568 (1952) *In German.*

See Abstr. 635 (1953). Further discussion of the relation between the uncertainty relation and the concept of statistical correlation. E. H. SONDHEIMER

530.162

5868. A simple derivation of the distribution functions for Bose and Fermi statistics. H. SCHMIDT. *Z. Phys.*, **134**, *No.* 4, 430–1 (1953) *In German.*

530.162 : 536.71

5869. TFD functions for non-zero temperatures and equations of state based on them. K. UMEDA AND Y. TOMISHIMA. *J. Phys. Soc. Japan*, **8**, 360–4 (*May–June*, 1953).

By means of the Lidiard distribution function for free electron gas, the Thomas–Fermi–Dirac (TFD) equations for non-zero temperatures are derived and integrated numerically for Fe. On the basis of the TFD functions there are given also the equations of state of metals under extremely high pressures. A.

MECHANICAL MEASUREMENTS 531.7

531.787

5870. On the conditions of the performance of an absolute mercury manometer. V. T. SLAVYANSKĬI. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1881–4 (1952) *In Russian.*

A description is given of the Pearson manometer used for measuring pressures of gas mixtures containing up to 90% of water vapour. The range of pressures measured varied from 0·01 to 1·5 mm Hg. The sensitivity over the entire range was 0·002 mm. The original paper by Pearson omitted several important considerations for effective use which are here described. These include the strict thermostating of the manometer below room temperature (15°C), the reduction of jolts and shakes, the purity of the mercury and the cleanliness of the glass surfaces. When the manometer is used for thermal analysis of gaseous mixtures it is necessary to take into account the temperature of the gas investigated and to correct by the Reynolds formula. The use of such a manometer is recommended for the analysis of gaseous mixtures containing easily condensible components. E. RABKIN

MECHANICS OF FLUIDS 532

532.123

5871. A test of the theory of secondary viscoelastic stress. M. MOONEY. *J. appl. Phys.*, **24**, 675–8 (*June*, 1953).

Experimental data published by Garner, Nissan and Wood on secondary stresses in a viscoelastic liquid have been analysed in terms of the superelasticity theory of secondary stresses as developed by Mooney. The theory was slightly modified to be consistent with the reported viscosity rate of shear behaviour of the test liquid. With this modification the theory agreed within experimental error with observed normal stresses at various radii on a stationary circular plate mounted parallel to a rotating plate. One reported qualitative experimental result is in disagreement with the theory, but this particular result is questioned. Other theories of secondary stress are briefly discussed. A.

532.123

5872. Viscoelastic properties of dilute polymer solutions. P. E. ROUSE, JR AND K. SITTEL. *J. appl. Phys.*, **24**, 690–6 (*June*, 1953).

The viscoelastic properties of dilute solutions of

chain polymers have been measured at frequencies in the range from 200 c/s to 60 kc/s. The data are compared with theoretical curves calculated from the steady flow viscosities of the solution and solvent, the molecular weight and concentration of the polymer, and the absolute temperature; this calculation made use of equations obtained from a recently developed theory. The equations contain no adjustable constants. The theory is shown to be at least a good first approximation to the viscoelastic properties of the solutions studied. The agreement of the data and the theory implies that, up to 60 kc/s at least, the viscoelastic properties of dilute solutions of polystyrene and polyisobutylene are the result of the thermal motions of the segments of the polymer molecules. These segmental motions co-ordinate with one another to produce changes in the configurations of the molecules. The configurational changes have associated with them a series of relaxation times. These relaxation times are shown to depend upon molecular weight of the polymer, concentration, type of solvent and viscosity of solvent. A.

532.13

5873. Temperature coefficients of non-Newtonian viscosity at fixed shearing stress and at fixed rate of shear. A. B. Bestul and H. V. Belcher. *J. appl. Phys.*, **24**, 696–702 (*June*, 1953).

Viscosity decreases with increasing shearing stress or rate of shear in the non-Newtonian flow of high polymeric systems. It is shown that it follows from this fact that the variation of viscosity with temperature is greater at fixed shearing stress than at fixed rate of shear. For such systems, it is shown experimentally that the variation of viscosity with temperature at fixed shearing stress is independent of shearing stress. However, the variation at fixed rate of shear is always less than that at very low shearing stress, and decreases with increasing rate of shear. This behaviour is reproduced by Eyring's hyperbolic sine flow equation, which is the antecedent for most other, more adequate, non-Newtonian flow equations. However, this equation is shown to be inadequate in that it predicts incorrect values of shearing stress for the occurrence of non-Newtonian behaviour. A.

532.13

5874. Effects of rate of shear on inherent and intrinsic viscosities of polystyrene fractions. L. J. Sharman, R. H. Sones and L. H. Cragg. *J. appl. Phys.*, **24**, 703–11 (*June*, 1953).

Fractions of polystyrene, varying in molecular weight from $0{\cdot}3\times10^6$ to 10×10^6 approximately, were prepared by careful tertiary fractionation. Inherent viscosities were determined at various rates of shear in the approximate range 100–20 000 sec^{-1}, viscosity measurements being made at several different temperatures in benzene and toluene (good solvents for polystyrene), in butanone (an intermediate solvent), and in cyclohexane (a poor solvent). From these values intrinsic viscosities at various rates of shear were determined. These viscosity functions are sensitive to shear rate at high molecular weights; at a given temperature the shear effects are greater the higher the molecular weight and the better the solvent, and with increasing temperature they decrease in a good solvent and increase in a poor one. This behaviour is shown to be consistent with current ideas regarding the size and shape of polymer molecules in solution as affected by weight, temperature and solvent power. It is concluded, among other things, that with flexible polymers (or polymer fractions) of very high molecular weight, measurements of intrinsic viscosity should be made in a poor solvent at a low temperature. A.

532.13

5875. Activation energy for viscous flow and short-range order. G. J. Dienes. *J. appl. Phys.*, **24**, 779–82 (*June*, 1953).

Viscosity-temperature properties of many systems are characterized by highly temperature-dependent activation energies for viscous flow. It is generally recognized that structural changes taking place in the material as a function of temperature are responsible for this phenomenon. In this paper a formulation of viscosity-temperature relations is presented in which the structural changes are explicitly taken into account by means of the formalism of short-range order as a function of temperature. The resulting equation is shown to be a generalization of several semi-empirical equations in current use. The equation has been applied to several glasses, high polymers and water and has been found to describe the experimental viscosity data with high accuracy over a wide temperature range. A.

532.13 : 532.73

5876. Dynamic mechanical properties of the system polystyrene-decalin. L. D. Grandine, Jr and J. D. Ferry. *J. appl. Phys.*, **24**, 679–84 (*June*, 1953).

The dynamic rigidities and viscosities of solutions of polystyrene (number-average molecular weight 197 000) in decalin have been measured by three experimental methods over ranges of concentration from 10 to 62%, of temperature from −5° to 50°C, and of frequency from 30 to 2000 c/s. Similar measurements were made on the undiluted polystyrene from 115° to 133°C and 30 to 2800 c/s. The data for the solutions, when reduced to a reference state of unit density and viscosity at a standard temperature, provide single composite curves for dynamic rigidity and viscosity. The distribution function of relaxation times calculated from these curves overlaps that previously derived from stress relaxation measurements on this system, and the combined function covers a range of time scale of ten powers of ten. It shows the three characteristic regions previously identified in the relaxation distribution function of polyisobutylene; there are no obvious anomalies associated with the fact that decalin is a very poor solvent for polystyrene. The data for the undiluted polymer, when reduced to a standard temperature, provide single composite curves for dynamic rigidity and viscosity. The temperature reduction factors provide apparent energies of activation for relaxation which agree with those for viscous flow obtained by Fox and Flory. The relaxation distribution function of the undiluted polymer is similar in shape to, but somewhat sharper than, those for other polymers in the transition from soft to glassy consistency. When reduced to a reference state of unit density and viscosity, the distribution function of the undiluted polymer lies

near that reduced from data on solutions, but is considerably sharper than the latter. A.

532.133 : 541.64

The effect of inhomogeneity on the relation between viscosity and molecular weight for polymer solutions. *See Abstr.* 6302

532.137

5877. Anomalous viscous flow at very low rate of shear and small shearing stress. J. T. BERGEN AND W. PATTERSON, JR. *J. appl. Phys.*, **24**, 712–19 (*June*, 1953).

Describes a translated cylinder, or translational, viscometer of a modified Pochettino type, which possesses a shear stress sensitivity of 5×10^{-3} dyne/cm^2 and a shear rate sensitivity of 1×10^{-4} sec^{-1}. A rubber Latex of high solids content exhibited no anomaly of flow within this range of sensitivity. A rubber dissolved in organic solvent was observed to approximate a Bingham material of 0·05 dyne/cm^2 yield value, while a gum tragacanth suspension in water exhibited a yield value of 0·4 dyne/cm^2 with marked post-yield anomalous flow. Household paints exhibited yield value ranging from zero to 6 dyne/cm^2. These yield values were related to levelling-out of brushmarks, and to sagging or "curtain," except for examples exhibiting marked thixotropic behaviour. Industrial organosol coatings likewise possessed yield values ranging up to 5 dyne/cm^2 which were related to levelling characteristics. These yield values agree with those postulated by Waring from consideration of the forces of levelling of brushmarks. They are considerably smaller than those reported in the literature from extrapolation of flow curves from much higher rate of shear. A.

532.51/.52

5878. Remarks on the problem of slow motions in a rotating fluid. G. W. MORGAN. Note in *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 2, 362–4 (1953).

The problem of the slow motion of an inviscid, incompressible rotating fluid, recently studied by Stewartson [Abstr. 2455 (1952)] and, more especially, the motion of a sphere along the axis of rotation are studied. Stewartson overcame the principal mathematical difficulty of formulating the problem in a co-ordinate system in which the appropriate differential equation can be solved simply, and in which the sphere is a co-ordinate surface, by a transformation of the independent variables, but used inappropriate initial conditions. This question of intial conditions is now discussed in the light of results already obtained by Morgan [Abstr. 3371 (1951)]. Stewartson's results are shown to be correct, despite the fact that his initial conditions are inappropriate to the problem. His results satisfy the appropriate initial conditions rather than those apparently imposed by Stewartson to obtain them. The purpose of the note is to dispel erroneous ideas concerning the physical nature of the problem. J. S. G. THOMAS

532.51

5879. Tube flow with slight angular momentum. L. COLLATZ AND H. GÖRTLER. *Wiss. Z. Tech. Hochsch. Dresden*, **2**, *No.* 3, 347–52 (1952–53) *In German.*

Steady axially symmetric flow in a circular pipe is considered, when the angular momentum about the axis is not zero at the entry. The axial and radial components of velocity (u and v) and the pressure are to first order, unaffected by a small transverse component (w). w is obtained as a function of radial and axial distances by solving a linear second-order partial differential equation with the appropriate entry and boundary conditions. By solving an eigenvalue problem numerically, it is shown that w decays to zero faster with axial distance than do any departures from Poiseuille flow in u and v. J. G. OLDROYD

532.51

5880. A new proof of Lagrange's theorem in hydrodynamics. H. MASUDA. *J. Phys. Soc. Japan*, **8**, 390–3 (*May–June*, 1953).

A new proof of Lagrange's theorem about the persistence of curl vector is given in the light of recent theories of linear partial differential equations. Velocity potential for an arbitrary pressure distribution can be constructed as the extremal field. A.

532.517

5881. Discontinuous potential flow as the limiting form of the viscous flow for vanishing viscosity. I. IMAI. *J. Phys. Soc. Japan*, **8**, 399–402 (*May–June*, 1953).

The asymptotic behaviour of the viscous flow past an obstacle for vanishingly small viscosity is discussed on the basis of Prandtl's boundary layer theory together with Kirchhoff's dead water theory. If the pressure distribution around the obstacle is such that the separation of the boundary layer on the obstacle takes place, then the flow pattern should involve free streamlines extending from the separation points. From such considerations it is concluded that the asymptotic flow pattern around a smooth obstacle is a discontinuous flow with dead water region of the Kirchhoff type such that free streamlines leave the obstacle with a finite curvature equal to that of the obstacle at the separation point. A.

532.517

5882. Stability of a limiting case of plane Couette flow. B. ZONDEK AND L. H. THOMAS. *Phys. Rev.*, **90**, 738–43 (*June* 1, 1953).

A fluid is supposed to be viscous and incompressible. The flow examined is $u = gy$; $v = 0$ $(0 \leqslant y < \infty;\ -\infty < x < \infty)$. Its stability is investigated by the method of small vibrations. Accepting the legitimacy of the usual expansions, the problem is reduced to the solution of a transcendental equation containing one parameter apart from the unknown. It is rigorously shown that the solutions of this equation are such as to make all modes of vibration of the flow damped. A.

532.517.4 : 536.75

5883. A new theoretical and experimental verification of Meissner's entropy principle in hydrodynamics in the case of Couette flow. E. MAURER. *Z. angew. Phys.*, **4**, *No.* 12, 466–73 (1952) *In German.*

Experiments are described which define critical Reynolds numbers for the onset of turbulence, in flow of distilled water between a stationary inner cylinder and a rotating coaxial outer cylinder. The torque was measured on a central section of the inner cylinder, in an apparatus capable of measuring

viscosities with about 2% absolute error. Experiments were carried out with cylinder diameters in the ratios 1·083 and 1·443, at 20°, 30°, 45° and 60°c. Deductions from the calculated temperature of a liquid in laminar and turbulent flow lead to an "entropy criterion" for turbulence in qualitative agreement with experiment. J. G. OLDROYD

532.525

5884. An optical method for the study of impinging jets in a liquid stream. G. G. KRETSCHMAR AND H. W. WEDAA. *J. Opt. Soc. Amer.*, **43**, 526–30 (*June*, 1953).

A method of analysing the mixing characteristics of binary liquid jets in a liquid stream has been developed. It consists of a modified schlieren system in which the aperture of the camera lens acts as a circular schlieren knife edge. The liquid stream which is to be studied is placed in the schlieren field. This liquid stream is in a glass tube which is contained in a rectangular glass-sided cell filled with liquid of about the same index of refraction as the glass tube. This masks the refractive effect of the glass tube and much of the lens effect of the round cross-section of the stream. It is shown that for a definite minimum energy of injection, the mixing becomes essentially complete at the end of the mixing region. The region of mixing appears on the photographs as a region of special turbulence above the jet openings in which the jet energy is being dissipated. A.

532.527

5885. Existence consideration on the motion of vortex rings. K. MARUHN. *Wiss. Z. Tech. Hochsch. Dresden*, **2**, *No.* 3, 385–90 (1952–53) *In German.*

The existence theorem [see *Mathematische Zeitschrift*, **45**, 155 (1939) and *Transactions of the American Mathematical Society*, **42**, 497 (1937)] is used in a study of the motion of vortex rings. By successive approximation a formula is obtained and an example is discussed. T. C. TOYE

532.528 : 534.23

5886. Ultrasonically induced cavitation in water: a step-by-step process. G. W. WILLARD. *J. Acoust. Soc. Amer.*, **25**, 669–86 (*July*, 1953).

A 2·5 Mc/s, barium-titanate, spherically focusing radiator was used to produce cavitation in both degassed and aerated water entirely within the restricted, high-intensity focal region, remote from the water boundaries. The sonic intensity rises to 1·8 kW/cm², and the pressure amplitude to ±70 atm. at the focus. High-intensity illumination and an unusual high speed photographic technique permit observation and timing of the step-by-step process of cavitation development. Feather-shaped cavitation bursts are sporadically produced, being initiated in the insignificant quill portion nearest the radiator, then abruptly expanding to form the catastrophic plume portion. The plume is believed to be formed by myriads of microcavities, too small and close for individual observation. These two fundamental steps are identically produced, and with equal ease, both in degassed and aerated water. The whole action is over in several milliseconds, except that in the case of aerated water a third bubble step is produced. In aerated water, non-collapsing gas bubbles are generated by and concurrently with, the catastrophic step. These bubbles remain after collapse of the burst, to be blown off down stream by the sonically induced liquid streaming. The bubble step is not generated without the presence of the catastrophic step. The latter is generated only if the initiation step reaches a definite degree of development (not always attained). This requires sonic activation for increasing lengths of time for decreasingly smaller sonic intensities. Origination of the initiation step, and hence of the whole cavitation phenomena, is believed to occur whenever a stray nucleus (weak spot) streams into the high intensity sonic field. A.

532.57

5887. A method of control of a predetermined flow rate. H. H. REAMER AND B. H. SAGE. *Rev. sci. Instrum.*, **24**, 362–6 (*May*, 1953).

A relatively simple device for the predetermination and control of the rate of displacement of fluids at atmospheric and elevated pressures is described. It is believed that the rate of displacement may be maintained at a prescribed value with an uncertainty of not more than 0·05% and the error in the actual value of the rate is not more than twice as great. A.

532.595

5888. Small oscillations of water contained by plane walls. E. STORCHI. Note in *R.C. Accad. Naz. Lincei*, **12**, 544–52 (*May*, 1952) *In Italian.*

Mathematical. After brief recapitulation of the author's results obtained for the problem discussed in *Rendiconti dell' Istituto Lombardo di Scienze e' Lettere*, **72** (1949), the particular case of the determination of the configuration of the free surface of a liquid in contact with a plane wall inclined at θ to the horizontal is discussed. in order to find the connection between the known cases of $\theta = 30°$ (Greenhill's parabolic surface) and $\theta = 45°$ (Kirchhoff's rectilinear surface). The expression for the configuration in the more general case of $\theta = m/2p\pi$ is derived. S. WEINTROUB

CAPILLARITY 532.6

532.612

5889. Positive temperature coefficient of the surface tension of molten metallic mixtures. G. METZGER. Note in *Naturwissenschaften*, **40**, *No.* 6, 199 (1953) *In German.*

The temperature coeffs. of surface tension for molten Ag/Pb and Ag/Bi mixtures over a wide temp. and concentration region are positive, although those of the pure metals are negative. This is connected with strong negative heats of mixing and limited mutual solubilities. R. C. MURRAY

532.612 : 530.162

5890. Statistical mechanics of surface tension. A. HARASIMA. *J. Phys. Soc. Japan*, **8**, 343–7 (*May–June*, 1953).

It is shown that, by a comparatively simple procedure, the formula of surface tension in terms of distribution functions from purely statistical considerations can be derived. Surface tension is derived

as the increase of free energy which accompanies the increase of unit area of the interface between the liquid and the vapour phases. The expression obtained is the same as MacLellan's:

$$\gamma = \frac{1}{2}\int\int\int\int \frac{d\phi_{12}}{dR_{12}} \frac{x_{12}^2 - z_{12}^2}{R_{12}} \rho_s^{(2)}(z, \boldsymbol{R}_{12}) dz_1 dv_{12},$$

where γ is the surface tension, ϕ_{12} is the intermolecular potential and $\rho_s^{(2)}(z, \boldsymbol{R}_{12})$ is the excess pair density reckoned relative to an arbitrary Gibbs dividing surface. The above expression can be transformed into the form given by Bakker,

$$\gamma = \int (p_N - p_T) dz_1,$$

where

$$p_N(z_1) = kT\rho^{(1)}(z_1) - \frac{1}{2}\int\int\int dv_{12} \int_{z_1 - z_{12}}^{z_1} \frac{d\phi_{12}}{dR_{12}} \frac{z_{12}}{R_{12}} \rho^{(2)}(\zeta, \boldsymbol{R}_{12}) d\zeta,$$

$$p_T(z_1) = kT\rho^{(1)}(z_1) - \frac{1}{2}\int\int\int dv_{12} \frac{d\phi_{12}}{dR_{12}} \frac{x_{12}^2}{R_{12}} \rho^{(2)}(z_1, \boldsymbol{R}_{12})$$

This result coincides with that of Kirkwood and Buff which was derived by calculating stresses directly. The assumption of density discontinuity, which is often made in the theory of surface tension, is examined closely. A.

532.612.4 : 534.22

5891. The temperature dependence of the ultrasonic velocity and surface tension of ethylene glycols. K. ALTENBURG. *Z. phys. Chem.*, **201**, 91–6 (*Nov.*, 1952) *In German.*

Measurements were undertaken to establish whether an anomalous temperature dependence exists as in the case of thermal conductivity. No such effect was found and further it is shown why such an effect is unlikely. T. C. TOYE

532.65 : 551.576

5892. The surface tension of a cloud drop. L. DUFOUR. *Meded. K. Vlaamse Acad. Wetensch.*, **13**, *No.* 14, 12 *pp.* (1951) *In Flemish.*

The system consists of two phases: gaseous and liquid, separated by a surface phase, and of three components: air, water and dissolved salt. Thermodynamic relations are derived for $\partial\sigma/\partial T$, $\partial\sigma/\partial p'$, $\partial\sigma/N_2''$ and $\partial\sigma/\partial r$, where σ is the surface tension, p' the pressure in the gaseous phase, N_2'' the molar concentration of water in the liquid phase and r the average radius of curvature of the surface. If there is no salt or if there is only water these relations become simpler. If it is assumed that $\partial\sigma/\partial r = 0$, and $\partial\sigma/\partial p' = 0$ for atmospheric pressures, the relations can be used for adsorption problems. A. J. TAYLOR

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

5893. A contribution to the theory of dipole liquids. I. Theoretical studies. A. LÖSCHE. *Z. phys. Chem.*, **201**, *No.* 5–6, 302–17 (*Dec.*, 1952) *In German.*

Analyses the structure of pure, non-associated dipole liquids and evaluates the total equation of state, taking into account the mutual dipole-dipole interaction. The series obtained is convergent only when the energy of interaction is $< kT$. This result is explained as follows: the liquid consists of microscopically small crystalline regions of determinable diameter. These regions are always characterized by a preferred direction. The orientation complexes behave statistically so that the dielectric behaviour i.e. molecular polarization of the microcrystalline liquids, can be evaluated by known methods.

F. LACHMAN

532.739

5894. Correlation of solid metal and nonelectrolyte solubilities. P. L. AUER. Letter in *J. chem. Phys.*, **21**, 1113–14 (*June*, 1953).

Hildebrand's discussion for regular solutions [Abstr. 2472 (1952)] is shown to be applicable to non-regular solutions. It is pointed out that Kleppa's method (1942) for deriving useful thermodynamic quantities characterizing non-regularity must be made with caution. The optimum information from a set of solubility measurements should be derivable when Kleppa's method is augmented by that of Hildebrand. H. H. HODGSON

532.78 : 537.211

5895. Electric charging phenomena during crystallization and solution. B. KRAUSE AND M. RENNINGER. Note in *Naturwissenschaften*, **40**, *No.* 2, 53–4 (1953) *In German.*

Describes observations and results of measurements on the arrangement of small pentaerythrite crystals on the surface of aqueous solution. Electrostatic repulsion forces of circular symmetry have been detected between crystals. The crystals/solution potential difference is proportional to the length of crystals. If crystals are of different size, their mutual distances are roughly proportional to their sizes.

F. LACHMAN

MECHANICS OF GASES 533

533.16 : 536.23 : 536.633

5896. A simple method for the simultaneous determination of the specific heat, coefficient of viscosity and thermal conductivity of gases. H. SENFTLEBEN. *Z. angew. Phys.*, **5**, *No.* 1, 33–9 (1953) *In German.*

Starting with the definitions of the Nusselt, Grashof and Prandtl numbers an expression is derived relating the three coefficients for two different gases. Measurements of the loss of heat from an electrically heated wire are made for a gas of known constants and one whose properties are desired. Simple arithmetic enables the latter to be calculated. Results are tabulated for thirteen gases including organic vapours. Ethane is used as the standard for thermal conductivity and specific heat, carbon dioxide for the coefficient of viscosity. E. H. DOCK

533.5

5897. Methods of obtaining high vacuum by ionization. Construction of an "electronic pump." H. SCHWARZ. *Rev. sci. Instrum.*, **24**, 371–4 (*May*, 1953).

Calculations on the possibility of obtaining high vacuum in an electrical discharge are given. It is

hown that in a simple d.c. gas discharge practically o real pumping action is possible; in such a discharge nly clean-up, i.e. electrical adsorption, may be bserved. A real pumping action only results if it is ossible to get within a tube such a high ion current, y special arrangements, that the number of ionized as molecules transported with this current in one irection is greater than the number of gas molecules hat will diffuse back in the opposite direction. An lectronic high vacuum pump of real pumping action as been built; it starts pumping at about 10^{-3} mm Hg nd gives an ultimate pressure lower than 5×10^{-6} mm Hg. A.

533.5

5898. A high vacuum high speed ion pump. J. S. Foster, Jr, E. O. Lawrence and E. J. Lofgren. *Rev. sci. Instrum.*, **24**, 388–90 (*May*, 1953).

A vacuum pump based on the properties of a magnetically collimated electric discharge is described. It has a speed in the range 3000 to 7000 litres per sec and a base pressure in the order of 10^{-6} mm. A.

533.5

5899. Theory of steam-jet vacuum pumps. I. M. Lifshits and L. N. Rozentsveĭg. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1362–75 (1952) *In Russian.*

A study of a simple model of steam-jet pump. Formulae and graphs have been derived, enabling the pumping rate and final vacuum to be evaluated for different values of steam-jet parameters. F. LACHMAN

533.5 : 533.6.011.5

5900. Supersonic velocities in high vacua. H. Klumb, E. Robens and O. Scholz. Note in *Naturwissenschaften*, **40**, *No.* 6, 196–7 (1953) *In German.*

On thermodynamical grounds it seems probable that the velocity of the vapour emerging from the jet of a vapour diffusion pump may exceed the velocity of sound. A brief description is given of an experimental investigation of the velocity of the vapour in a mercury vapour jet at various pressures and angles of jet. Schlieren photographs are reproduced in the following cases: emergent jet angles 8° and 2·5° and pressures 10^{-3} and 10^{-1} mm Hg. Mach-angles are shown in profile. Mach numbers up to 2·5 were observed. A. B. WOOD

533.6.011.312

5901. Determination of the drag on a cylinder at low Reynolds numbers. R. K. Finn. *J. appl. Phys.*, **24**, 771–3 (*June*, 1953).

Drag coefficients for a cylinder were measured at Reynolds numbers from 0·06 to 6·0 by observing the deflections of thin wires suspended in an air stream. The results confirm a theoretical equation proposed by Lamb and are consistent with experimental data of other investigators. A.

533.6.011.4

5902. Plane jet of gas emitted from a nozzle with supersonic velocity. Z. Hasimoto. *J. Phys. Soc. Japan*, **8**, 394–9 (*May–June*, 1953).

When a plane jet of gas issues steadily from a symmetrical nozzle as a parallel supersonic stream into an external medium at rest, its behaviour is governed by the exit velocity as well as by the ratio of exit pressure to pressure in the external medium. As will be seen from Prandtl's photographs, when this pressure ratio is nearly equal to unity, the jet has a periodic character to the first approximation, and its structure can be accounted for by the use of the linear theory due originally to Prandtl. When the pressure ratio departs from unity, however, the quantitative behaviour, such as the wavelength of the jet, cannot be fully explained unless the non-linear character of the fundamental equation is taken into account. In the present paper, the fundamental equation for the stream function is considered in the hodograph plane, and the true adiabatic relation is replaced by an approximate adiabatic one so that simple exact solutions may be obtained. Thus, it is shown that, if the exit velocity is not so close to the sonic velocity and the external pressure is not lower than that at the exit, the jet has, to the present approximation, still a completely periodic structure down-stream as in the case of the linear theory. An expression is obtained for the wavelength of the jet and it is found that agreement between theoretical result and Prandtl's experiments is very satisfactory. A.

MOLECULAR THEORY OF GASES 533.7

533.7

5903. Pressure virial coefficients in terms of cluster integrals. W. E. Putnam and J. E. Kilpatrick. Letter in *J. chem. Phys.*, **21**, 1112 (*June*, 1953).

Density virial coefficients have been obtained in terms of cluster integrals [Abstr. 2260 (1953)] and the present note indicates how the pressure virial coefficients can be obtained for the general case in a similar manner. See also Abstr. 2259 (1953).

533.7

5904. Molecular distribution functions in a one-dimensional fluid. Z. W. Salsburg, R. W. Zwanzig and J. G. Kirkwood. *J. chem. Phys.*, **21**, 1098–107 (*June*, 1953).

Exact expressions are derived for the molecular distribution functions in a one-dimensional fluid whose particles interact with a nearest neighbour pair potential. The pair distribution function for rigid spheres is found to be identical with Frenkel's resuit. The one-dimensional form of a new set of integral equations for the molecular distribution functions is examined. The superposition principle is found to be exact in a one-dimensional fluid with nearest neighbour interactions. A.

VIBRATIONS . ACOUSTICS 534

534.131

5905. Acoustical vibrations of rings. E. R. Kaiser. *J. Acoust Soc. Amer.*, **25**, 617–23 (*July*, 1953).

The frequencies of tones when metal rings are struck in radial and axial directions have been investigated in a variety of steel and bell-metal rings. The classical formulae relating frequency with ring

dimensions and physical properties of the materials compare closely with actual measurements except for thick rings. The fundamental tone is predominant in the smaller rings but the fundamental fades and the overtones predominate as the rings increase in diameter and decrease in width and thickness. Comments are given on musical properties of rings which may be promising but which have not been fully explored. A.

534.132

5906. A circular-orifice number describing dependency of *primary Pfeifenton* frequency on differential pressure, gas density, and orifice geometry. A. B. C. ANDERSON. *J. Acoust. Soc. Amer.*, **25**, 626–31 (*July*, 1953).

A non-dimensional number $(\Delta p/\rho)^{\frac{1}{2}}/ft$ for *primary Pfeifentöne* relating the dependence of differential pressure Δp across orifice to density of gas ρ, thickness t of orifice-plate terminating pipe, and frequency f of *primary Pfeifentöne* is obtained by dimensional analysis. Correlation of experimental data presented on the basis of this number indicates that it is relatively constant in numerical value over range of variation of the parameters, pipe length, orifice diameter, differential pressure across orifice and *Pfeifentöne* frequency studied. A.

534.152

5907. The use of the shadow method in acoustics. P. N. KUBANSKIĬ. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1871–6 (1952) *In Russian.*

The ordinary method of using differences in refractive index of air or gas to obtain pictures of, e.g., nodes in acoustic field or gas flow fail at low intensities. However, the author finds that by placing small heated objects such as wires in the field, there is an intensification of the phenomena and pictures are successfully obtained. Illustrated by seven photographs of applications to various physical phenomena. E. RABKIN

534.213

5908. The behaviour of resonant systems in the field of sound waves of large amplitude. P. N. KUBANSKIĬ. *Zh. tekh. Fiz.*, **22**, *No.* 9, 1483–93 (1952) *In Russian.*

An experimental investigation in the range 8·6–33·6 kc/s of the way in which a plane wave reacts with small cylindrical cavities in the walls of a cylindrical tube. It is shown that violent motion of the air in the cavities is produced at resonance and that loss of heat by the tube is increased due to the turbulent flow. Photographic records are included and also the effect of a combination of acoustic wave and turbulent flow of air. J. M. HOUGH

534.213

5909. Detection in gels and glasses of resonance frequencies dependent on the material. L. HOLZAPFEL AND G. GLEITSMANN. Note in *Naturwissenschaften*, **40**, *No.* 2, 53–4 (1953) *In German.*

Describes an apparatus for determination of characteristic resonance peaks (at frequencies in the range 50–300 c/s) in gels or vitrified substances (e.g. sodium silicate glasses obtained by neutralization of Na silicate solution with different acids), and graphs some of the results obtained. F. LACHMAN

534.21

5910. On the physics of sound radiation pressure. F. BORGNIS. *Z. Phys.*, **134**, *No.* 3, 363–76 (1953) *In German.*

The paper discusses the radiation pressure on a plane obstacle due to the hydrodynamic impulse of a free stream of plane compression waves. The expression for the radiation pressure is given in terms of Euler and Lagrange variables. Reference is made to the Rayleigh pressure and to Brillouin's strain tensor and the interchange effect between a free acoustic stream and the surrounding medium. The paper concludes with a discussion of the radiation pressure and energy density relations. A. B. WOOD

534.211

5911. Large amplitude vibrations of rods and tubes at audiofrequencies. J. N. BRENNAN. *J. Acoust. Soc. Amer.*, **25**, 610–16 (*July*, 1953).

A new apparatus for investigation of sound propagation constants for large amplitude audio-frequency vibrations in metals is described. One novel feature of the apparatus is the use of tuned resonant supports that are tilted with respect to the specimen. The tilting minimizes the tendency to chatter due to the Poisson effect. Because the supports are driven at their resonant frequency, large amplitudes may be achieved without the occurrence of an energy loss due to slipping at the contact surfaces between supports and test specimen. The error caused by energy dissipation due to the internal friction of the support is, in most cases, negligible. In those cases where it is not negligible, it can be closely estimated and corrected for. Auxiliary equipment permits determination of the resonant frequency of the specimen to better than 1/1000. The total error in the determination of the logarithmic decrement varies between 2% and 5%. A.

534.213

5912. Sound propagation in gross mixtures. W. S. AMENT. *J. Acoust. Soc. Amer.*, **25**, 638–41 (*July*, 1953).

For low acoustic frequencies, a mixture (a porous medium or a suspension) is shown to have an effective density which differs slightly from the density given by Archimedes' principle. This effective density is computed from a physically elementary consideration of viscous, incompressible fluid flow. For higher frequencies, pore or particle size in the mixture becomes comparable with the wavelength of shear waves in the fluid, while still small compared with dilatational wavelength. The theory is extended to such frequencies through the known formula for the fluid's resistance to the oscillations of a rigid sphere. In both cases, the effective compressibility of the mixture is taken to be the volume-average of the component compressibilities. From the effective density and compressibility, the acoustic properties of the mixture are predicted. Predictions are compared with previous theories, and with experimental results. A.

534.22

5913. The velocity of ultrasound in human and animal tissue. A.-H. FRUCHT. Note in *Naturwissenschaften*, **39**, *No.* 21, 491–2 (1952) *In German.*

Tests were made at 1·8 Mc/s on specimens

$\times 1 \times 1 \cdot 5$ cm, using a power of 70 mW/cm² at the greatest and with the specimens thermoelectrically controlled to prevent temperature fluctuations. Human subcutaneous fatty tissue showed an increase of velocity from 1460 m/sec when nearly dry to about 1490 m/sec at a moisture content of 24%, and appeared to be approaching asymptotically to the value of 1496 m/sec for pure water. The adiabatic compressibility was computed from the density and the velocity of ultrasound and was found greater than that of water. For human and animal liver tissue, the velocity fell with increase of moisture content to reach that of water at 100% saturation, but the compressibility was below that of water.

A. C. WHIFFIN

534.22

5914. Ultrasonic dispersion in water solutions of magnesium sulfate. F. E. Fox and T. M. Marion. *J. Acoust. Soc. Amer.*, **25**, 661–8 (*July*, 1953).

In a dispersive medium the relative phases of the components of a complex sound wave change with path length. The present article describes a method of measuring dispersion in which the change in relative phases of a complex wave consisting of a fundamental and a selected harmonic are measured as a function of the path length. Sensitivities, in measuring difference in velocity, of one part in 10^5 with a probable error of 3 parts in 10^5 were obtained experimentally. Dispersion measurements made in water solutions of $MgSO_4$ below one megacycle show linear dependence upon concentration up to 0·5 mole per litre and agree with those calculated from absorption data. The data indicate a total dispersion of $13 \cdot 6 \times 10^{-4}$ per mole per litre, with a relaxation frequency of 160 kc/s at 24°C. A.

534.22 : 533.7

5915. Sound dispersion in *cis*- and *trans*-dichloroethylene vapors. M. Boudart. Letter in *J. chem. Phys.*, **21**, 955–6 (*May*, 1953).

Contrary to Sette *et al.* [Abstr. 1457 (1953)], *trans*-dichloroethylene cannot be considered as an ideal gas. The values of v_0 (sound velocity reduced to zero pressure), calculated for both isomers using the second virial coefficients of the Berthelot equation of state, yield single dispersion waves for each isomer, there being no marked difference in the behaviour of the isomers. F. LACHMAN

534.23

5916. Investigation of sound absorption in aqueous solutions of electrolytes in the frequency range 3 to 100 Mc/s. G. Kurtze. *Nachr. Akad. Wiss. Göttingen, Math.-phys. Kl. IIa*, **1952**, *No.* 9, 57–79 *In German.*

The dependence of absorption on frequency, concentration, temperature and pH values is measured using two types of optical methods. The results are discussed at length and it is shown that in all cases the effects can be explained by a relaxation process.

T. C. TOYE

534.23

5917. Measurements of sound absorption in water and aqueous solutions of electrolytes in the frequency range 5 kc/s to 1 Mc/s. K. Tamm. *Nachr. Akad. Wiss. Göttingen, Math.-phys. Kl. IIa*, **1952**, *No.* 10, 81–110. *In German.*

The absorption coefficient in this range is measured, by resonance methods, relative to that of pure water. 1–1 valence salts show zero or very little absorption while 2–2 and higher electrolytes show very large absorption; particular note should be made that a relaxation maximum occurs for the divalent metallic sulphates, the position in the frequency range depending upon the metal, the absorption increases with frequency indicating a further maximum at high frequencies. A discussion of relaxation theory is given. T. C. TOYE

534.23

5918. On the method of the determination of the absorption of ultrasonic waves in metals. N. F. Otpushchennikov. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1867–70 (1952) *In Russian.*

A new and simple method of determining the absorption of ultrasonic waves in metals is described. Data are given on the absorption in the following substances: zinc, lead, tin, rosin and methyl methacrylate. The measurements were carried out at a frequency of 3·5 megacycles. The apparatus used is described in earlier papers [*Phys. Zeits d. Sowjetunion*, **12**, 736 (1937) and Abstr. 8743 (1952)].

E. RABKIN

534.23

5919. Ultrasonic absorption in magnesium sulfate solutions. P. L. Connolly and F. E. Fox. *J. Acoust. Soc. Amer.*, **25**, 658–60 (*July*, 1953).

The ultrasonic absorption coefficients in water solutions of magnesium sulphate were measured at 30 Mc/s as a function of temperature and concentration. Temperatures from 0 to 30°C and concentrations from 0·05 to 2·00 molarity were used. Measured data were used to calculate Q, the absorption cross-section per molecule of magnesium sulphate at several temperatures. Q is defined by $(2\alpha_M/\nu^2)/N$ where N is the number of molecules of magnesium sulphate per cm³, ν is the frequency and α_M is the amplitude absorption coefficient caused by the magnesium sulphate. These are constant for concentrations up to 1 molarity but decrease by 50% for 2 molarity concentration. The constant values of $Q \times 10^{37}$, 25 at 25°C, 30 at 20°C and 37 at 15°C, indicate an activation energy for the magnesium sulphate absorption process at 30 Mc/s of 6·8 kcal/mole°K. A.

534.23

5920. Thermal effect of ultrasonic waves at frequencies of 3 Mc/s and above. S. Parthasarathy, D. Srinivasan and S. S. Chari. *Z. Phys.*, **134**, *No.* 4, 398–407 (1953) *In German.*

The authors continue their work [see Abstr. 1675 (1951); 2269 (1953)]. A correlation had been found at 420 kc/s between the heat output and α/ν^2 which was again more or less confirmed at 5 Mc/s in the latter paper above if a constant empirical value was assumed for $h/(\alpha/\nu^2)$. The present work shows for several liquids that at 3 Mc/s and above the relation between h and the classical value of α/ν^2 does not hold and further it would appear that at very high frequencies the heating effect will be the same for all liquids. T. C. TOYE

534.23

5921. The relationship between the intensity of sound at the sound radiator and the absorption coefficients in liquids. S. PARTHASARATHY, S. S. CHARI AND D. SRINIVASAN. *Z. Phys.*, **134**, *No.* 4, 408–12 (1953) *In German.*

Radiation pressure methods of measurement show that the theoretically expected inverse proportionality of intensity to resistance of the liquid does not exist. The ratio of intensity to absorption coefficient is found constant, except for anomalously absorbing liquids, at 5 Mc/s; at 15 Mc/s, however, there does not appear to be any relation between I_0 and α.

T. C. TOYE

534.23

5922. Effect of losses on transmittivity of plates. R. D. FAY. *J. Acoust. Soc. Amer.*, **25**, 623–5 (*July*, 1953).

The theory of the transmittivity of immersed plates is extended to include the effects of losses associated with shear waves. The loss is computed for the transmission maxima which occur for five modes of vibration and is compared with observations made at a fixed frequency of 1½ megacycles. The general agreement is good but not within the experimental error for all of the five modes. The value of the loss factor, which was determined to give agreement in a simple case, is difficult to appraise without data at other frequencies.

A.

534.23 : 541.14

5923. Sonochemistry: The production of chemical changes with sound waves. A. WEISSLER. *J. Acoust. Soc. Amer.*, **25**, 651–7 (*July*, 1953).

An extensive survey is made of the chemical effects of ultrasonic waves. Increased understanding of the mechanism of these effects is sought through a consideration of the significance of certain experimental variables such as frequency, intensity, pressure and temperature. Also considered is the role of cavitation.

A.

534.231.3

5924. Note on acoustic impedance. H. O. TAYLOR. Letter in *J. Acoust. Soc. Amer.*, **25**, 75–6 (*May*, 1953).

Reference is made to the earlier paper by Taylor [Abstr. 704 (1953)] on sound absorption measurements. The method used to determine the motional impedance is described. Two equivalent telephone receivers are used with the entire vibrating surfaces exposed, and are joined by a short length of tube so as to make a very thin sound-proof air compartment between the diaphragms.

G. F. HODSMAN

534.232

5925. An acoustic gyrator. W. E. KOCK. Letter in *J. Acoust. Soc. Amer.*, **25**, 575 (*May*, 1953).

An acoustic analogue of the microwave gyrator described by Hogan [Abstr. 2854 (1952)] is discussed. The experimental arrangement includes a circular guide which is rotated at high speed. The non-reciprocal nature of the device is stressed.

G. F. HODSMAN

534.24 : 535.312 : 538.566

5926. Total reflection of waves from a point source. E. GERJUOY. *Commun. pure appl. Math.*, **6**, 73–91 (*Feb.*, 1953).

An analysis is made of the reflection of a pulse of sound from a point source in a non-absorbing liquid plane boundary, under the circumstance that the index of refraction is < 1. The analysis is equally applicable to the total reflection of electromagnetic radiation from a vertical dipole, in the absence of absorption. The results clarify the mechanism of propagation of the head wave which has been observed in acoustic experiments. It is shown without approximation that a pulse is received in the first medium at a time corresponding to propagation along the surface with wave velocity of the second medium. Under certain circumstances a pole in the complex plane of integration makes a contribution to the field at long distances. However, the pole always lies on the imaginary axis for non-absorbing media, giving rise to an exponentially decreasing term at long distances. Thus no true (undamped) surface waves can occur. The contribution from this pole is absent in the electromagnetic case when, as is usual, the magnetic permeabilities of the two media are equal.

A.

534.26

5927. On the diffraction of a plane sound wave by a paraboloid of revolution. II. C. W. HORTON. *J. Acoust. Soc. Amer.*, **25**, 632–7 (*July*, 1953).

For Pt I, see Abstr. 1681 (1951). Some numerical values have been computed for the functions which arise in connection with the scalar wave equation in rotational paraboloidal co-ordinates. Tables of these values are given with the aid of which a numerical analysis is carried out of the scattering of a plane sound wave by a rigid convex paraboloid of revolution. The surface of the paraboloid is defined by $k\xi_0 = 0{\cdot}25$ and the direction of propagation of the plane wave makes an angle of 36·9° with the axis of symmetry of the paraboloid. The asymptotic expansions of the scattered waves are discussed and their amplitudes are tabulated. The magnitude and phase angle of the total pressure are evaluated at points on the surface of the paraboloid.

A.

534.372

5928. On the thermal damping of elastic vibrations. Reply to Mr. E. Schreuer. C. ZENER. *Z. Phys.*, **134**, *No.* 4, 426–7 (1953) *In German.*

A criticism of the final formula for the damping given in Abstr. 5631 (1952), mainly based on an assumption that a simple functional relationship exists between temperature, volume and entropy in an elastic solid, independent of the elastic distortion.

J. G. OLDROYD

534.372

5929. The thermal damping of elastic vibrations. E. SCHREUER. *Z. Phys.*, **134**, *No.* 4, 428–9 (1953) *In German.*

Reply to the preceding paper (preceding abstract). It is suggested that the criticism can be avoided by preserving a distinction between the dependence of temperature on volume and on proportional volume change in an adiabatic deformation process.

J. G. OLDROYD

534.41 : 550.834

5930. Piezoelectric well hydrophones. C. B. Vogel. *J. Acoust. Soc. Amer.*, **25**, 711–18 (*July*, 1953).

Information about the velocity of sound in the earth is normally obtained by shooting dynamite at the surface and measuring travel time to a detector suspended by cable within a deep well. In such measurements errors are sometimes introduced by noise transmitted down the cable. A piezoelectric hydrophone for use in deep wells was constructed and has been useful in discriminating against such noise. Hydrophones are also well suited for tandem use in wells to measure interval velocities. Their substantially aperiodic response facilitates resolution of shear waves, and their relatively constant coupling to the earth makes possible measurement of attenuation. Several types of hydrophone are described and the results of some field experiments are discussed. A.

534.41 : 550.834

5931. Sound waves observed in mud-filled well after surface dynamite charges. J. R. Ording and V. L. Redding. *J. Acoust. Soc. Amer.*, **25**, 719–26 (*July*, 1953).

An array of three pressure pick-ups 100 ft apart covering a vertical range of 200 ft was used to record sound waves in two wells drilled to depths exceeding 12 000 ft. Dynamite charges were exploded in 80 ft holes at a distance of 500 ft from the well-head. A separate charge was fired with the array at each 500 ft interval in the well. The recorded events were analysed and found to belong to two categories. The first category includes the pressure pulse arriving at the pick-up by a more or less direct route through the sedimentary rocks. The second consists of events set up in the mud column at points other than adjacent to the pick-up by the compressional wave in the sedimentary rocks. These events then travel through the mud column and are recorded as they pass the pick-up. Anomalies in the hole, such as the ends of casing strings and the bottom of the hole, cause events of larger amplitude than those set up in sections of the hole with no major anomalies. A.

534.41

5932. A compact, versatile filter-type sound analyzer. H. H. Scott and D. von Recklinghausen. *J. Acoust. Soc. Amer.*, **25**, 727–31 (*July*, 1953).

Availability of a pocket-sized miniature sound level meter meeting all ASA standards has created demand for a small, equally portable sound analyser as a companion instrument. The analyser described surpasses all applicable ASA standards. The separate high and low cut-off filters may be adjusted independently, and the noise pass band may be locked in any bandwidth which is an integral multiple of ½ octave, from ½ octave through the standard 1 octave band, etc. The range of the filters extends 1 octave lower and 1 octave higher than the ASA standards. These features permit considerable added precision and flexibility of analysis. For protection and ease of carrying, the instrument is housed in a leather case similar to those used for amateur motion picture cameras. The case is equipped with a shoulder strap which allows the analyser to be carried about easily while in use. It can also be used as a general purpose adjustable filter or as a wide-range amplifier. A.

534.614

5933. A field meter for sound velocity measurements. R. C. McLoughlin and J. R. Chiles, Jr. *J. Acoust. Soc. Amer.*, **25**, 732–4 (*July*, 1953).

The travel time of sound across a fixed gap between diaphragms of transmitting and receiving transducers is recorded each 1/500 sec. From this the inter-diaphragm velocity is computed. It is a function of both temperature and wind. Spurious travel time changes introduced by phase shifts in the receiver are minimized by using a 500 c/s intelligence signal amplitude modulating a 10 kc/s carrier. Experimental errors when operating in air with interdiaphragm distances of 3 ft are less than 2% in the temperature range from 70° to 200°F, but the application of the instrument is not restricted to this range. A circuit for recording velocity directly on a paper tape is described. Although designed primarily for air, the unit is adaptable to other media. It should also be of special interest to the micrometeorologist. A.

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 6341–6

534.78

5934. An electrical analog of the vocal tract. K. N. Stevens, S. Kasowski and C. G. M. Fant. *J. Acoust. Soc. Amer.*, **25**, 734–42 (*July*, 1953).

The design and construction of an electrical analogue of the human vocal tract is described. The vocal tract is viewed as an acoustic tube of varying cross-sectional area, terminated by the vocal cords at one end and by the lip opening at the other. The analogue is a lumped-constant electrical transmission line consisting of 35 π-sections. Each section represents a ½ cm length of the vocal tract and is adjustable to simulate a range of cross-sectional areas from 0·17 to 17 cm². The electrical line can be excited by a periodic current source representing the vocal cord output or by a random voltage representing the noise from turbulent air flow at a constriction. The electrical analogue can synthesize with good quality all English vowels and some consonants. The physical characteristics of the output of the analogue for each sound are shown in terms of measured formant frequencies or by conventional spectrograms. For each sound, the vocal tract dimensions that the electrical network simulates are shown in graphical form. Applications of the speech synthesizer to linguistic and engineering research are discussed briefly. A.

534.78

5935. A new microphone-controlled light flash stroboscope for the observation of vocal lip movements. W. Hanle and G. Podzuweit. *Z. angew. Phys.*, **5**, *No.* 2, 41–3 (1953) *In German.*

A description is given of an electronic system by means of which a microphone operated by the voice of a speaker or singer controls the instant of flashing of a stroboscope. Arrangements are made to vary the phase of the flashes, so that the lip movements of the singer can be studied. A. B. WOOD

534.844 : 534.78

5936. On the influence of returning sound on the direction localization and intensity of speech. E. MEYER AND G. R. SCHODDER. *Nachr. Akad. Wiss. Göttingen, Math.-phys., Kl. IIa*, **1952**, *No.* 6, 31–42. *In German.*

In free space only the direct sound waves from a speaker are received by the hearer, but in closed rooms there are in addition a more or less large number of returning sound waves following the direct sound. These returning waves (*Rückwürfe*) reach the ear from different directions and after varying time intervals. In the case when the time differences between the direct and returning sound are small the observer becomes confused as to the true direction of the primary sound, i.e. in cases where the returning sound waves are not distinguishable as echoes. The paper describes an experimental investigation of the direct, returning, and total sound as a function of the time difference between the direct and returning sound. Speech is recorded on an endless magnetic tape and a "primary" loudspeaker, and up to 9 auxiliary "return wave" (*Rückwürf*) loudspeakers are fed via amplifiers from two pick-ups on the tape, which can be relatively adjusted to introduce any desired time interval from, say, 1 to 200 milliseconds between the primary and the returning "wave" loudspeakers. The observer receives sound from any or all of these. The practical application of the experimental results is discussed particularly to the case of electroacoustic amplification of speed and music in large halls and in the open. Reference is made to the work of H. Haas [Abstr. 1604 (1952)], and of Parkin and Taylor in St. Paul's Cathedral [Abstr. 4200 (1952)].

A. B. WOOD

OPTICS . RADIATION . SPECTRA 535

535.241.4

5937. Optical method for the measurement of luminous intensity, brightness and luminous flux. A. A. VOL'KENSHTEĬN, D. I. ANDREEV AND V. I. ISAENKO. *Zh. tekh. Fiz.*, **22**, *No.* 12, 2026–37 (1952) *In Russian.*

Light is refracted by an objective lens on to a selenium photoelement and the resultant photocurrent is observed. The theory of the method due to A. A. Gershun is given. The influence on the measurements of aberrations in the objective, the size of the light source and its distance from the instrument are examined experimentally and presented graphically. The method is found to be superior in sensitivity to other existing methods.

W. BARDSLEY

535.317

5938. Note on toric wave fronts. J. J. FARIS. Letter in *J. Opt. Soc. Amer.*, **43**, 406 (*May*, 1953).

The dioptric power of a wavefront of light that has been refracted by a toric refracting surface is found, after it has moved some distance beyond the plane of refraction. The wave front is no longer toric. The application to spectacle lenses is briefly considered.

R. W. FISH

535.317 : 535.42 : 538.3

5939. Deduction of the laws of reflection of geometrical optics on the basis of the asymptotical treatment of problems in diffraction. M. I. KONTOROVICH AND YU. K. MURAV'EV. *Zh. tekh. Fiz.*, **22**, *No.* 3, 394–407 (1952) *In Russian.*

Considers the deduction of asymptotic formulae for surface integrals from oscillatory functions (method of stationary phase). With the assistance of these formulae, a connection between the laws of reflection of geometrical optics and the laws of classical electrodynamics is established as emerging from the integral formula of problems in diffraction.

W. BARDSLEY

535.323 : 535.345 : 666.22

5940. Optical characteristics of a 980 : 222 glass. R. A. WEIDEL. Letter in *J. Opt. Soc. Amer.*, **43**, 540–1 (*June*, 1953).

The optical properties of a new glass of the PbO–WO_3–P_2O_5 system containing traces of CdO and TiO_2. It absorbs X-rays, has a refractive index of 1·98 and its reciprocal dispersion is 22·2.

R. O. DAVIES

535.33.03

5941. Spectrophotometry of the flame. M. PINTA. *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 210–26 (*Sept.*, 1952) *In French.*

Detailed illustrated description of the design, construction and operation of an apparatus developed by the author. A special atomizer, in which a solution of the analysed compound is atomized by compressed air, is connected with a glass vessel (homogenizer) out of which the mist enters the burner fed with acetylene under pressure. The radiation of the flame is concentrated by an elliptical mirror on to the spectrograph slit. The spectrograph used by the author has an aperture *F*/8, a range of 4000–9000 Å, length of spectrum 10 cm, and a dispersion ranging from 13 Å/mm at 4000 Å to 100 Å/mm at 8000 Å. It is more advantageous to use a spectrograph than a monochromator. The vacuum photo-emission tube, type Boutry–Gillod, is connected through a double electrometric tube Mazda "E_2" with a sensitive galvanometer. The use of the photoelectric setup is described for the measurement of both the flame emission and photographic blackening. The last chapter deals with the techniques of flame spectrophotometry, particularly with the factors affecting atomization, the interaction between the elements in the flame, and, finally, the application of the flame spectrophotometry to analytical purposes. A table showing the sensitivity of the method for a number of elements is included.

F. LACHMAN

535.33.03

5942. Flame spectra of rare earths. M. PINTA. *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 260–70 (*Dec.*, 1952) *In French.*

Presents results of spectrographic investigations on the oxyacetylene flame spectra of Sc, Y, La, Ce, Pr, Nd, Sa, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu, conducted with the aid of apparatus described in a previous paper (preceding abstract). The oxyacetylene flame causes a strong excitation of a limited number of very intense emissions in the spectra of rare earths which lend themselves for numerical

evaluation, as the spectral background and other emissions are relatively feeble. A method of spectrophotometric quantitative analysis of mixtures of two rare-earth metals, using the oxy-acetylene flame spectra, is outlined and discussed, and a table is enclosed showing the sensitivity of the spectrophotometric and spectrographic methods for the most characteristic wavelengths of the spectra of the 15 elements referred to above. F. LACHMAN

535.33.03 : 535.376

5943. The application of the so-called Volta luminescence in spectrum analysis. D. LÖBELL. *Z. angew. Phys.*, **4**, *No.* 12, 462–6 (1952) *In German.*

The Volta luminescence is the glow observed, in certain circumstances, at the electrodes of a discharge through an electrolyte. The paper deals with the spectroscopic observation of the glows with reference to its use in spectroscopic analysis. Elements studied include Tl, Ca, Pb, Li and Ge. J. D. CRAGGS

535.33.07

5944. An apparatus for automatic recording of reflection spectra. J. H. SCHULMAN AND C. C. KLICK. *J. Opt. Soc. Amer.*, **43**, 516–19 (*June*, 1953).

A system permitting the automatic recording of ultraviolet and visible reflection spectra has been constructed, in which a function-generating potentiometer, operating in synchronism with the wavelength drive of a conventional spectral reflectance apparatus, attenuates the phototube output to compensate for the spectral distribution of the light source, the wavelength dependence of the monochromator transmission, and the spectral sensitivity of the phototube. The potentiometer is tapped at points corresponding to about 100 Å intervals from 2200 Å to 7000 Å, and the resistances between taps are adjusted to give a constant recorder deflection when MgO is used as a sample. Once the potentiometer has been adjusted in this way, a direct record of spectral reflectance of an "unknown" sample is obtainable in a few minutes. A.

535.33.07

5945. Construction of a dual beam heated infrared cell. J. T. NEU. *J. Opt. Soc. Amer.*, **43**, 520–1 (*June*, 1953).

The construction of a heated dual beam infrared gas cell for a Perkin–Elmer Model 21 spectrophotometer is described. The cell windows of sodium chloride are sealed to the cell by means of silicone stopcock grease. This seal has been found to be satisfactory up to a temperature of 350°C. A.

535.33.07 : 771.3

5946. Note on fast spectrographic camera design. C. J. SILVERNAIL. Letter in *J. Opt. Soc. Amer.*, **43**, 539–40 (*June*, 1953).

In the design of an $f/2{\cdot}0$ spectrograph camera employing a concentric meniscus—mirror system, a change in the meniscus—mirror spacing can be used to correct the residual spherical aberration resulting from small departures from the calculated thicknesses. The achromatism of the system can be altered by moving the corrector relative to the mirror, a shift of $\pm 5\%$ being adequate to cover the u.v., i.r. and visual regions. The residual aberrations are said to be small. R. W. FISH

535.338.332

5947. Hyperfine structure of the spectrum of gadolinium. S. SUWA. *J. Phys. Soc. Japan*, **8**, 377–81 (*May–June*, 1953).

The hyperfine structures of 32 lines of Gd I and 2 lines of Gd II in the visible region were measured. They could be interpreted as due to the isotope displacement effect of the even isotopes (156, 158 and 160) and the splittings due to the nuclear magnetic moments of the odd isotopes (155 and 157). The ratio of the isotope displacements $\Delta(158-156)/\Delta(160-158) = 0{\cdot}97 \pm 0{\cdot}06$ was determined. The relative isotope displacement $\Delta(160-158)$ in some 30 terms of Gd I is tabulated. A.

535.338.332 : 539.153

5948. The fine structure of the $(^4S^0)3p\ ^3P$ term of oxygen O I. D. O. DAVIS AND K. W. MEISSNER. *J. Opt. Soc. Amer.*, **43**, 510–11 (*June*, 1953).

The fine structure of the $(^4S^0)3p\ ^3P$ term of O I has been determined by interferometric measurement of three triplets at 8446 Å, 7245 Å and 6046 Å. The term is found to be partially inverted in agreement with Edlén's findings. A.

535.338.333

5949. On some regularities in the isotope effect in the spectrum of lead. II. K. MURAKAWA. *J. Phys. Soc. Japan*, **8**, 382–7 (*May–June*, 1953).

For Pt I, see Abstr. 1971 (1953). The hyperfine structures of the Pb I lines λλ5201, 5005, 7228, 4168, 4062, 4020, 3740, 3672, 3573, 4058, 2873, 3683, 3640, 2833 and Pb II lines λλ6660, 4386·4, 5042·5, 4153 and Pb III line λ4182·5 were measured, and the ratio of the distances of the adjacent even isotope components $\Delta\nu(206-204)/\Delta\nu(208-206)$ was determined to be $0{\cdot}905 \pm 0{\cdot}010$. The ratio $\Delta\nu(207-206)/\Delta\nu(208-207)$ was found to be constant for all lines (except λ4062) within experimental error and was found to be $0{\cdot}615 \pm 0{\cdot}008$. The anomaly found in the case of λ4062 is interpreted as being due to a perturbation. A.

535.338.334

5950. Experimental examination of the systematic errors of equivalent widths. G. TRAVING. *Z. Astrophys.*, **31**, *No.* 2, 175–81 (1952) *In German.*

The systematic errors inherent in a spectrophotometric determination of the equivalent widths of spectral lines have been investigated with the aid of artificially-produced lines of known total absorption. It is found that the magnitude of the error depends partly on the photographic density of the continuum, and that there is little dependence of measured line-width on the instrumental dispersion. D. R. BARBER

535.338.334

5951. Quantum theory of spectral line broadening. S. BLOOM AND H. MARGENAU. *Phys. Rev.*, **90**, 791–4 (*June* 1, 1953).

Simple radiation theory is used to derive a formula proposed earlier by P. W. Anderson [Abstr. 844 (1950)] for calculating the intensity within a collision-broadened spectral line. The problem is considered, first from the point of view of molecular transitions, and then by computing the work done by the light wave. The general result for absorption is stated in

an equation, wherein the first double integral represents true absorption, the second induced emission. A.

535.342/.343 : 548.7

5952. On the temperature dependence of electron levels in crystals. K. H. PAETZOLD AND H. KRÖMER. Note in *Naturwissenschaften*, **40**, *No.* 5, 163–4 (1953) *In German.*

This note gives a qualitative and elementary explanation of the difference between the pressure and the temperature dependence of the spectra of trivalent Cr and Nd ions in crystals, as obtained by Paetzold [Abstr. 4246 (1951)]. P. T. LANDSBERG

535.343–15

5953. Apparatus developments in infrared spectroscopy. I–II. E. LIPPERT. *Z. angew. Phys.*, **4**, *No.* 10, 390–7; *No.* 11, 434–40 (1952) *In German.*

535.343.32

5954. Absorption spectra of methaemoglobin and its fluorides, rhodanides, cyanides and nitrites. R. HAVEMANN AND P. WOLF. *Z. phys. Chem.*, **201**, *No.* 5–6, 246–60 (*Dec.*, 1952) *In German.*

The methaemoglobin was obtained by electrodialysis of horse blood. The various compounds were made from the protein solution. Spectra were taken in solutions with pH 6·8 to 9·05. The apparatus is described: its sensitivity was such that accurate measurements were possible from 1200 mμ to 330 mμ. The frequencies found and the extinction coefficients are extensively tabulated. Although the general appearance of the spectra, such as the stepwise decrease in extinction towards the infrared, is similar, important differences are found as far as the region of shortest waves investigated. It is concluded that these lines must be due to the different acid residues themselves, and not to the changes of the protein caused by the various end groups.

A. J. TAYLOR

535.343.32

5955. A new phenomenon in the absorption spectrum of the picrate ion. G. BRIEGLEB AND G. ANGERER. Note in *Naturwissenschaften*, **40**, *No.* 3, 107–8 (1953) *In German.*

The absorption band at 4000 Å of sodium picrate in a butanol-heptane mixture is dependent on the butanol-heptane ratio. It disappears for a ratio of 1 : 50. The band at 3300 Å decreases too. Addition of small amounts of basic substances cause reappearance of the band. This is due to a specific chemical equilibrium where the NO_2 group takes on an electron, forming more or less stable resonance complexes. Possible forms are given. A similar equilibrium occurs probably in the crystal. The conductivity is also dependent on acidity. C. TURNER

535.343.4

5956. Broadening and shift of the second doublet of the rubidium absorption series under different pressures of argon and helium. S.-Y. CH'EN AND D. A. KOHLER. *Phys. Rev.*, **90**, 1019–21 (*June* 15, 1953).

The shift and broadening of the second doublet of the principal series of rubidium produced by argon and by helium were studied for pressures up to 123·5 atm. (rd 52) and up to 97·5 atm. (rd 44), respectively. The red shift produced by argon gives a linear relationship with its relative density, rd. The slopes for both components of the doublet are 2·95 cm^{-1}/rd. The violet shift produced by helium in the high pressure range is greater than linear with the rd. The $^2P_{\frac{1}{2}}$ component is shifted more than the $^2P_{\frac{3}{2}}$ component. Argon shows a nicely linear broadening for both components over the entire range of rd. For the $^2P_{\frac{3}{2}}$ component the broadening is 2·28 cm^{-1}/rd and for the $^2P_{\frac{1}{2}}$ component it is 2·11 cm^{-1}/rd. Helium appears to give a definite quadratic broadening, particularly for the $^2P_{\frac{3}{2}}$ component. A.

535.343.4–14 : 539.133

5957. The microwave spectrum and structure of ozone. R. H. HUGHES. Letter in *J. chem. Phys.*, **21**, 959–60 (*May*, 1953).

Twenty-eight lines, including some for the O^{18} isotopic molecules, are identified. Angle 116·7 ± 0·4°, bond length 1·277 ± 0·003 Å, dipole moment 0·58 ± 0·03 D. D. H. WHIFFEN

535.343.4–15

5958. Measurement of the intensity of the vibration-rotation rays of carbon monoxide. J. VINCENT-GEISSE. *C.R. Acad. Sci.* [*Paris*] **236**, 2049–51 (*May* 27, 1953) *In French.*

535.343.4–15

5959. The infrared spectrum of fluoroform from 2·2 to 20 μ. H. D. RIX. *J. chem. Phys.*, **21**, 1077–9 (*June*, 1953).

The absorption spectrum of fluoroform has been investigated with a Perkin–Elmer double-pass spectrometer from 2·2 to 20 μ. The resolution is sufficient to make possible an unequivocal assignment of all six fundamentals on the basis of the observed band envelopes. An anomaly is found in the symmetrical C–F stretching vibration; on the evidence now available this vibration should be assigned to the parallel band at 1209·3 cm^{-1} in the infrared (vapour) and to the polarized Raman line (liquid) at 1117 cm^{-1}. Overtone and combination bands measured include the A_1 and E components of the second harmonic of each of the three degenerate fundamentals. The separation of the maxima of the P and R branches of the parallel bands is discussed in relation to the theory of Gerhard and Dennison. A.

535.343.4–15

5960. Absorption line width in the infrared spectrum of atmospheric carbon dioxide. A. ADEL. *Phys. Rev.*, **90**, 1024–5 (*June* 15, 1953).

Line width in the 15 micron band of atmospheric carbon dioxide has been determined by direct observation of line contour. The influence of finite width of slit has been eliminated by numerical correction. 0·12 cm^{-1} is an upper limit for the CO_2 absorption coefficient half-width at half-height. A.

535.343.4–15 : 535.375.5

5961. Infrared and Raman spectra of fluorinated ethanes. VI. The series CF_3CH_3, CF_3CH_2Cl, CF_3CHCl_2, and CF_3CCl_3. J. R. NIELSEN, C. Y. LIANG AND D. C. SMITH. *J. chem. Phys.*, **21**, 1060–9 (*June*, 1953).

For Pt V, see Abstr. 3142 (1953). The infrared spectra of gaseous CF_3CH_2Cl and CF_3CHCl_2 have been obtained in the range from 2 to 38 μ, and the

spectra of the liquids in the range from 2 to 22 μ, with the aid of LiF, NaCl, KBr and KRS-5 prisms. The Raman spectra of these compounds in the liquid state have been photographed with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å. Depolarization ratios were determined for most of the Raman bands. All fundamental vibrational frequencies have been assigned; the spectra have been interpreted in detail and thermodynamic functions have been calculated. A.

535.343.4–15 : 535.375.5

5962. Infrared and Raman spectra of fluorinated ethanes. VII. CCl_3CF_2Cl and CCl_3CFCl_2. J. R. Nielsen, C. Y. Liang, D. C. Smith and M. Alpert. *J. chem. Phys.*, **21**, 1070–6 (*June*, 1953).

The infrared spectra of liquid CCl_3CF_2Cl and of CCl_3CFCl_2 as glass and in CS_2 solution, have been obtained in the region from 2 to 38 μ with the aid of LiF, NaCl, KBr, and KRS-5 prisms. The Raman spectra of these compounds in the liquid state, at about 50° and 120°C, respectively, were photographed with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å. Relative intensities and depolarization ratios were measured for all but the weakest Raman bands. Complete assignments of fundamental vibration frequencies have been made, the spectra have been interpreted in detail, and thermodynamic functions have been calculated. A.

535.343.4–32

5963. Absorption coefficients of oxygen in the vacuum ultraviolet. K. Watanabe, E. C. Y. Inn and M. Zelikoff. *J. chem. Phys.*, **21**, 1026–30 (*June*, 1953).

Absorption coefficients of oxygen were measured at several hundred wavelengths in the region 1050–1900 Å with a one-metre vacuum monochromator and a phosphor-coated photomultiplier as detector. The absorption intensity of the Schumann–Runge continuum was found to be somewhat less than previous results, and the intensity distribution was less symmetrical. The 19–0 and 20–0 bands of the Schumann–Runge progression were observed and the dissociation limit of the $B^3\Sigma_u^-$ state was 57 140 ± 60 cm^{-1}. Several other bands and continua were found at shorter wavelengths. A.

535.343.9 : 539.133

5964. Absorption spectrum of free HCO radicals. D. A. Ramsay. Letter in *J. chem. Phys.*, **21**, 960–1 (*May*, 1953).

The emission bands at 2500–4100 Å were not observed in absorption. But new bands were found with heads at 6138·2 and 5624·1 Å. Analysis of these leads to values for bond lengths and angle.

G. F. LOTHIAN

535.343.9–15 : 541.124

5965. Studies by infrared spectra on the initiation process in autoxidation of methyl linolenate. N. A. Khan. Letter in *J. chem. Phys.*, **21**, 952 (*May*, 1953).

Methyl hydroxy linolenate (more stable than the unstable peroxides of methyl linolenate) has been found to show absorption in the same regions of the infrared spectrum as the linoleate, as far as the geometric isomers of the double bonds are concerned. Hence methyl linolenate may follow the same pattern of reactions as methyl linoleate during the initial stage of autoxidation. F. LACHMAN

535.345 : 535.39

5966. On the optical absorption and reflection of amorphous and hexagonal selenium. J. Stuke. *Z. Phys.*, **134**, *No.* 2, 194–207 (1953) *In German.*

Photoelectric measurements in the range $\lambda = 300$–1200 mμ show decrease of absorption constant and reflection factor with increasing λ. The absorption constant decreases sharply at 550 mμ corresponding to the activation energy of 2·3 eV found by Henkels [Abstr. 6975 (1951)]. Near this wavelength curves of optical density show a shoulder which is more pronounced in crystalline films formed by heating the amorphous film under pressure to 170°C; and the reflection curve for the crystalline form shows a definite maximum here. Conversion at 210°C sharpens the maximum and gives another at $\lambda \sim 400$ mμ. Measurements at −170°C yield steeper curves; absorption constants are greater for crystalline forms. Results are discussed in terms of the crystal model. G. F. LOTHIAN

535.345–15

5967. Optical properties of bismuth in the near infrared. L. G. Schulz. Letter in *J. Opt. Soc. Amer.*, **43**, 406–7 (*May*, 1953).

The optical constants n and k of bismuth films have been calculated from transmissivity measurements on ten thicknesses (350–1200 Å) in the wavelength range of 0·4–4 μ. Bismuth becomes relatively transparent in the infrared due to the low density of free electrons. This explanation of the wavelength variation of n and k is consistent with modern theories of solids. R. A. WEALE

535.371

5968. Wavelength dependence of the fluorescence of organic phosphors in the X-ray region. G. Breitling. *Z. angew. Phys.*, **4**, *No.* 11, 401–9 (1952) *In German.*

The wavelength dependence of fluorescence from various materials, such as anthracene, naphthalene, chloranthracene, etc., is studied in the X-ray excitation region from 0·078–1·78 kX. The fluorescence yield remains practically constant over this range. Study is made of fluorescence from these substances as impurities in solution in hydrocarbons such as benzene and chlorbenzene. The chlorbenzene molecules have a quenching effect on fluorescence as expected theoretically. G. F. J. GARLICK

535.371

5969. On the decay time of solid solutions of aromatic hydrocarbons. A. Schmillen, L. Schmillen and F. Rohde. *Z. Naturforsch.*, **8a**, 213–14 (*Feb.–March*, 1953) *In German.*

By using a fluorometer (light modulated at 10·7 Mc/s) the decay times of fluorescence of anthracene and its naphthacene impurity are obtained for different naphthacene concentrations. The anthracene decay time decreases as the latter rises. The spectral emission of pure anthracene changes with grinding and the decay time decreases. Both emission and decay time return to original state on remelting. Difference in energy states between

surface and volume of the crystal is assumed to be responsible. G. F. J. GARLICK

535.371

5970. The surface effect of sodium iodide scintillators. E. DER MATEOSIAN AND L. C. L. YUAN. *Phys. Rev.*, **90**, 868–9 (*June* 1, 1953).

The response of NaI(Tl) crystals to α-particles originating outside of the crystal was compared to that of α-particles originating within the crystal in order to determine any possible surface effects of the crystal. It was found that any such effect, if present, is too small in magnitude to explain the non-linearity of response of NaI(Tl) crystals to α-particles of energy less than 8 MeV. A.

535.371

5971. Measurement of the phosphorescence decay of some alkali halides. H. NEUERT AND T. RETZ-SCHMIDT. *Z. Phys.*, **134**, *No.* 2, 165–72 (1953) *In German.*

535.371

5972. Influence of lattice defects, produced by pressure, on the luminescence of ZnS phosphors. I. BROSER AND W. REICHARDT. *Z. Phys.*, **134**, *No.* 2, 222–44 (1953) *In German.*

The decrease of efficiency of ZnS–Cu phosphor with increasing grinding has been studied quantitatively and considered theoretically on the band model. The number of defects was estimated optically. The experimental results can be explained on the hypothesis that the defects introduced by pressure lead to discrete metastable states in the forbidden zone. Excitation to these states competes with excitation to luminescent states, for transitions from them are radiationless. J. EWLES

535.375.5

5973. On the Raman spectrum of monomeric methyl methacrylate at −180°C. S. C. SIRKAR AND N. K. ROY. Letter in *J. chem. Phys.*, **21**, 938–9 (*May*, 1953).

The effect of polymerization on the Raman spectrum of methyl methacrylate has been determined by observations of the spectra of the monomer at 28°C and at −180°C and of the polymer at 28°C. G. I. W. LLEWELYN

535.375.5

5974. The Raman spectra of hexamethyldisilane and hexamethyldisiloxane. H. MURATA AND M. KUMADA. Letter in *J. chem. Phys.*, **21**, 945 (*May*, 1953).

The Raman displacements and relative intensities of the observed lines are tabulated. G. I. W. LLEWELYN

535.375.55

5975. The Raman frequency of bromine monochloride. H. STAMMREICH AND R. FORNERIS. Letter in *J. chem. Phys.*, **21**, 944–5 (*May*, 1953).

Observations on a chlorine-bromine mixture dissolved in CCl_4 are briefly discussed. G. I. W. LLEWELYN

535.376

5976. The scintillation response from NaI(Tl) crystals under bombardment with positive ions of energies 60–600 keV. S. K. ALLISON AND H. CASSON. *Phys. Rev.*, **90**, 880–5 (*June* 1, 1953).

The scintillations of NaI(Tl) under ion bombardment have been investigated, using monoenergetic H, D, He, and Ne ions in the kinetic energy range 60–600 keV. The light output caused electrical pulses in a photomultiplier tube (Type EMI 5311), which were then sorted in magnitude by means of a single channel pulse height analyser. Single peaked pulse-height distributions were observed for each ion energy. The most probable pulse height was found to increase linearly with energy for each of the ions. The pulse height (most probable) *v.* energy lines for H, D, and He were found to extrapolate through the origin, with an experimental uncertainty of perhaps 10 keV in the energy intercept. The slopes of these lines, giving the relative scintillation efficiencies, were observed to be in the ratios $1 : 0{\cdot}96 \pm 0{\cdot}03 : 0{\cdot}75 \pm 0{\cdot}05 : 0{\cdot}54 \pm 0{\cdot}03$ for the H, D, He, and Ne ions, respectively. It is concluded that the response of NaI(Tl) to protons is approximately the same as for electrons of the same energy, since an extrapolation of the proton pulse-height curve to 661 keV gave the same pulse height as was observed for the photopeak of the Cs^{137} γ-ray of that energy. The importance of "hard" (i.e. nuclear) collisions, which may not produce scintillations, is brought forward as a factor which may enter into the explanation of the lowered scintillation efficiency for the heavier ions. A.

535.39

5977. Titanium dioxide films as selective reflectors of the near-infrared. F. J. STUDER AND D. A. CUSANO. *J. Opt. Soc. Amer.*, **43**, 522–5 (*June*, 1953).

Owing to the high refractive index of TiO_2, films of this material show a great difference in reflection between the spectral regions of constructive and destructive interference. A glass slide coated on one side with a film of such thickness as to give its first order reflection maximum at 11 000 Å and its reflection minimum at 5500 Å, will reflect approximately 30% at 11 000 Å and 8% at 5500 Å. If the glass is coated on both sides, it will reflect in the neighbourhood of 40% of the integrated infrared from a tungsten lamp operated at 2700°K, while it reflects only 8% at 5500 Å. A series of experiments with incandescent lamps was undertaken to determine the effect of such coatings applied to the bulbs. Uniform TiO_2 coatings of the proper thickness were deposited on the inside and outside of clear spherical bulbs, and the light output measured from compact filaments when carefully centred inside a coated bulb and when centred in an uncoated bulb. It was found that, for a given power input, the light output from the coated bulb was as much as 20% higher than from the uncoated bulb. For the same light output, 10% less power input was required in the coated bulb. Because this result was obtained only when spherical non-frosted bulbs with accurately centred small filaments were used, it is questionable whether this process will have any practical applications in connection with incandescent lamps. A.

535.39

5978. The oblique transmission factor of multilayer thin films. W. WEINSTEIN. Letter in *J. Opt. Soc. Amer.*, **43**, 539 (*June*, 1953).

Two different definitions of transmission appear in the literature. These are identified as, respectively, the illumination transmission factor and the luminous

lux transmission factor. Under some conditions the definitions give identical results, under others the results differ. These are discussed. It is shown that the appropriate definition should be selected according to the special case considered. S. TOLANSKY

535.417

5979. Adjustment of Mach–Zehnder interferometer for white-light fringes. R. J. CLARK, C. D. HAUSE AND G. S. BENNETT. Letter in *J. Opt. Soc. Amer.*, **43**, 408–9 (*May*, 1953).

A sequence of operations is described which enable rapid adjustment of a Mach–Zehnder interferometer, especially for securing white light fringes. The direction of translation to be taken is indicated by the curvature of the fringes, the apparent centre of curvature showing in which direction the adjusting plate must be moved. S. TOLANSKY

535.417

5980. Wavelength or length measurement by reversible fringe counting. E. R. PECK AND S. W. OBETZ. *J. Opt. Soc. Amer.*, **43**, 505–9 (*June*, 1953).

Optical and electronic means have been devised and tested for reversible counting of fringes from a corner-cube or Michelson interferometer. Counting rates of 1000/sec have been achieved, but do not represent the attainable limit. A.

535.417 : 531.715.1

5981. Film thickness measurement for grating blanks. F. A. MCNALLY. Letter in *J. Opt. Soc. Amer.*, **43**, 540 (*June*, 1953).

A simple interferometric method for the measurement of the thickness of metallic films deposited on grating blanks is described. The method can be applied to films greater than 500 Å in thickness.

D. G. AVERY

535.417 : 535.822.9

5982. The testing of shape with micro-interference. A new surface interferometer. R. LANDWEHR. *Z. angew. Phys.*, **4**, *No.* 10, 377–86 (1952) *In German.*

The Linnik type of micro-interferometer is modified to accept and examine relatively large workpieces. By the introduction of a long dividing prism interferometric tests can be carried out over a surface length of 12 cm. An instrument is described employing the proposed modification. The workpiece can be traversed over the full length and the system has industrial and technological applications. A comprehensive literature is included. Interferometric accuracy is 0·03 μ. S. TOLANSKY

535.421

5983. Note on the theory of gratings. B. A. LIPPMANN. Letter in *J. Opt. Soc. Amer.*, **43**, 408 (*May*, 1953).

Rayleigh's treatment of the scattering of a plane scalar wave by a perfectly reflecting grating is shown to represent the scattered field only approximately. An alternative method of treatment, using the Schwinger variational principle, is proposed.

D. G. AVERY

535.435 : 539.133

5984. A light scattering investigation of the polymolybdates. M. KESTIGIAN, P. COLODNY AND R. S. STEIN. Letter in *J. chem. Phys.*, **21**, 952–3 (*May*, 1953).

Absolute turbidity measurements on solutions of sodium molybdate give molecular weights of 480 and 2500 for the MoO_4'' ion in neutral and acid solution respectively; this is in qualitative agreement with other evidence. G. F. LOTHIAN

535.435 : 539.133

5985. Angular distribution of the light scattered by random coils. H. BENOIT AND M. GOLDSTEIN. Letter in *J. chem. Phys.*, **21**, 947 (*May*, 1953).

A theoretical comparison of the light distributions assuming different distribution functions for the positions of the coil elements. G. F. LOTHIAN

535.65

5986. A comparison of the MacAdam and the Adams–Nickerson indexes of color differences. G. W. INGLE AND L. RUDICK. *J. Opt. Soc. Amer.*, **43**, 501–4 (*June*, 1953).

A simplified version of the MacAdam equation for colour difference is presented. It is used in comparison with the Adams–Nickerson index for hypothetical colours in C.I.E. space and for colours of selected plastic samples. The two indexes disagree seriously except when the colour difference involves differences in only one, and the same, chromaticity co-ordinate. Visual estimates of colour differences shown by plastic samples show preferential agreement with the MacAdam index. The suggestion is made that this simplified MacAdam formula be given wider trial. A.

535.65

5987. Dependence of color-mixture functions on choice of primaries. D. L. MACADAM. *J. Opt. Soc. Amer.*, **26**, 533–8 (*June*, 1953).

The shape of the colour-mixture curve for any primary is completely determined by the choice of the line in the chromaticity diagram representing the additive mixture of the other two primaries. Formulae for the linear combinations necessary to transform one set of colour-mixture curves to another are given in terms of the slopes and axis-intercepts of the lines joining the new primaries, represented in the chromaticity diagram based on the original colour-mixture functions. Orthogonal colour-mixture functions are defined and an example is given, in which one of the colour-mixture functions is proportional to the luminosity function. Formulae for deriving all other orthogonal sets of colour-mixture functions are given. The importance of the concept of orthogonality in the analysis of the propagation of errors in spectrophotometric colorimetry is discussed. A.

535.65 : 535.243

5988. Propagation of errors in spectrophotometric colorimetry. I. NIMEROFF. *J. Opt. Soc. Amer.*, **43**, 531–3 (*June*, 1953).

An important part of the basis of instrumental colorimetry, namely, the uncertainty of spectrophotometric data, has been neglected in the investigations of colour and colour specification. The uncertainty of measurement of spectral data results from recurrent and random fluctuations such as slit-width and stray-energy effects and photometric-scale and wavelength-scale effects. By means of the theory of propagation

of errors in a computed result the variances in each of the CIE chromaticity co-ordinates are determined. As the chromaticity co-ordinates are correlated, the covariance between x and y is also determined. Uncertainty ellipses are formed by assuming that the variates have normal distributions about their mean values with the determined covariance matrix. These ellipses have been computed for a representative series of colours for the special case of constant spectral uncertainty. These ellipses are compared with the perceptibility ellipses of MacAdam. As in visual colorimetry, an instrumental measurement of chromaticity co-ordinates does not establish a single point on the chromaticity diagram, but rather indicates that the true chromaticity point probably lies within an elliptical area surrounding this point. A.

535.7 : 612.84

Physiological optics. *See Abstr.* 6338–40

535.824

5989. Possible uses of the new Leitz phase contrast apparatus with a Heine condenser. G. H. M. GOTTSCHEWSKI. *Z. wiss. Mikr.*, **61**, 185–200 (*Jan.*, 1953) *In German.*

This mirror condenser allows a microscope image to be seen in bright field, dark field or phase contrast by a simple adjustment of its position. Photographs illustrating its use are shown. R. W. FISH

535.824

5990. A note on the theory of phase-contrast images. H. H. HOPKINS. *Proc. Phys. Soc.* [*London*] *B*, **66**, 331–3 (*April*, 1953).

It is shown how a simple formula for the light distribution in a phase-contrast image may be obtained with only two restrictive assumptions. These are that the direct light should fall wholly within the phase-changing area, and that the "diffracted light" must be regarded as composed only of that which falls within the lens aperture but outside the phase-changing areas. It is concluded in particular that, subject to the above conditions, the aberrations of the illuminating wave have no effect on the image, and that no restriction concerning the size of the phase-perturbations in the object is necessary. H. H. HOPKINS

535.89

5991. Slit source in spectrophotometric measurements. K. S. VUL'FSON AND I. SH. LIBIN. *Zh. tekh. Fiz.*, **22**, *No.* 3, 525–9 (1952) *In Russian.*

Describes the construction of a slit source formed from a pair of tantalum or tungsten strips whose temperature can be raised to 2000°K or 3000°K by electrical means. W. BARDSLEY

HEAT 536

536.2.083 : 537.311.33

5992. A simple method of measuring thermal conductivity. A. V. IOFFE AND A. F. IOFFE. *Zh. tekh. Fiz.*, **22**, *No.* 12, 2005–13 (1952) *In Russian.*

The substance under investigation is clamped between an upper copper block A (temp T_a) and a lower copper block B (temp T_b). Initially the whole system is at ambient temperature T_0. The lower block is then immersed in a low temperature bath. The thermal conductivity of the material between blocks A and B is obtained from measurement of the time-variation of (T_a-T_b) and (T_a-T_0); an accuracy of 3–5% is claimed for individual determinations taking less than 5 min to carry out, and the method is applicable over the conductivity range 0·001 to 0·1 cal/cm.sec °c. Various applications of the method are outlined: (*a*) a study of the effect of plastic deformation of regular monocrystals (NaCl, AgCl) upon thermal conductivity; (*b*) the thermal conductivity of semiconductors; (*c*) a comparison of the thermal conductivities of amorphous and crystalline solids (e.g. sulphur and selenium). A. SCHOFIELD

536.21

5993. Conduction of heat in the semi-infinite solid with a short table of an important integral. R. C. TH SMITH. *Austral. J. Phys.*, **6**, 127–30 (*June*, 1953).

The solution of a problem in heat conduction is expressed in terms of the integral $\int_0^U e^{-\alpha(1+u^2)}\frac{du}{1+u^2}$. This integral is tabulated for various values of α and U. A.

536.21 : 539.31

5994. Determination of thermo-elastic stresses in a cylindrical tube. F. BUCKENS. *Mém. Acad. Roy. Belgique Cl. Sci.*, **27**, *No.* 5, 44 *pp.* (1952) *In French.*

A general steady-state solution for the temperature distribution in a cylindrical tube is obtained, when a linear combination of temperature and normal temperature gradient is known (as a function of position) on each of the two curved surfaces and two plane ends. A general method for deducing the thermal stresses and displacements throughout the tube, when this is elastic, is given in detail.

J. G. OLDROYD

536.212

5995. Heat conductivity of aluminium oxide at high temperatures. A. R. SHUL'MAN, V. N. FEDOROV AND M. A. SHEPSENVOL. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1271–80 (1952) *In Russian.*

Suggests a method of determining heat conductivity of ceramic materials at high temperatures, consisting in comparing results of measurements conducted by 2 methods: that of the shift of specific power characteristics, and the probe method. In the first method, differential measurements are carried out on specimens in which the substance tested forms a tubular layer around a W filament through which current is passed, while in the second, a thin W filament is wound around the specimen as described above and coated with a thin layer of the tested material; this thin W filament serves as resistance thermometer.

F. LACHMAN

536.212

5996. On the thermal conductivity of artificially produced graphite rods in the temperature ranges 3300 to 3700°K. J. EULER. Note in *Naturwissenschaften*, **39**, *No.* 24, 568–9 (1952) *In German.*

The sharp decrease from 0·2 to 0·057 in this range is probably due to a loosening up of the structure.

F. E. HOARE

536.212.2 : 537.311.31

Diffusion on the Fermi-surface and the conductivity of metals. *See Abstr.* 6037

536.23 : 536.633 : 533.16

A simple method for the simultaneous determination of the specific heat, coefficient of viscosity and thermal conductivity of gases. *See Abstr.* 5896

536.23 : 541.124

5997. Thermal conductivity in mixtures of chemically reacting gases. E. U. FRANCK. *Z. phys. Chem.*, **201**, 6–31 (*Nov.*, 1952) *In German.*

An expression for thermal conductivity in gaseous mixtures with components undergoing mutual chemical reactions is derived from the thermodynamics of irreversible processes. Apart from the diffusion stream, this expression contains also the stream of the reaction enthalpy, due to the thermal diffusion. Numerical calculations show that the effect of thermal diffusion can amount sometimes to as much as ½ of the normal thermal conductivity, but at the same time it does not amount to more than a few % of the pure diffusion effect. The equation developed for binary gas mixtures can be also used for the treatment of thermal conductivity of pure diatomic gases with a small excitation of rotation and vibration. F. LACHMAN

536.24 : 537.212

5998. Heat transfer in liquids under the action of electric fields. H. SENFTLEBEN. *Z. angew. Phys.*, **5**, *No.* 1, 39–40 (1953) *In German.*

Three cases are briefly considered: (*a*) liquids of low electrical conductivity in which the field has little effect and the heat transfer is mainly by conduction; (*b*) liquids in which perceptible currents pass, when the heat transfer is increased; (*c*) cases in which there is a decrease in transfer; these are in the minority. (*b*) and (*c*) can possibly be explained on the lines that the field affects the viscosity of the liquid and reference is made to the experiments of Hofmann [*Z. Phys.*, **92**, 759 (1934)] with a schlieren apparatus. E. H. DOCK

536.421

5999. New apparatus for the determination of points of fusion and solidification. C. PAQUOT AND R. PERRON. Note in *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 292–6 (*Dec.*, 1952) *In French.*

The requirements of an ideal unit are briefly considered and the new apparatus is illustrated and described. The sample is placed on a Pyrex disk fastened to a column so that it can be illuminated and examined optically. The column can be raised and lowered to place the specimen at known levels within a Dewar vessel and a double-walled glass tube axially aligned. The glass vessel contains oil which can be heated at the highest zone by a heating coil, and liquid air can be placed in the Dewar vessel. By this arrangement a vertical temperature gradient of −80°C to 130°C is produced. The temperature of the specimen is measured by a thermocouple to 0·1°C. The image of the specimen can be examined visually or photographed. E. H. DOCK

536.421.4

6000. An apparatus for the rapid determination of freezing point diagrams. L. A. BURKARDT, D. W. MOORE AND W. S. MCEWAN. Note in *Rev. sci. Instrum.*, **24**, 461–2 (*June*, 1953).

536.423 : 541.123.2.034.6

6001. Determination of partial pressures from the total pressure of liquid mixtures; consequences of the Duhem–Margules equation. M. V. STEIN AND H. VOETTER. *Z. phys. Chem.*, **201**, *No.* 3–4, 97–110 (*Dec.*, 1952) *In German.*

The Duhem–Margules equation can be used for the calculation of the partial pressures of the components of a binary mixture from the total pressure, especially in the case of strongly positive systems. Simple methods for the rapid integration, numerical and graphical, of the Duhem–Margules equation are indicated, and the corresponding formulae for mixtures of more than two components are considered. A. J. MEE

536.423.1 : 536.51

6002. The normal boiling points of oxygen on the thermodynamic scale. J. G. ASTON AND G. W. MOESSEN. Letter in *J. chem. Phys.*, **21**, 948 (*May*, 1953).

Three independent readings of a specially designed gas thermometer against 7 platinum resistance thermometers gave 17 values for the normal boiling point of O. The mean difference between the readings of the gas thermometer and those of the Pt resistance thermometers is $+0{\cdot}0359 \pm 0{\cdot}0013°$. Thus the normal boiling point of O in centigrade degrees on the thermodynamic scale is $-182{\cdot}970 - 0{\cdot}036 = -183{\cdot}006°$ or 90·154°K. F. LACHMAN

536.424

6003. Transition temperatures in some dihydrogen and dideutero phosphates and arsenates and their solid solutions. C. C. STEPHENSON, J. M. CORBELLA AND L. A. RUSSELL. Letter in *J. chem. Phys.*, **21**, 1110 (*June*, 1953).

Figures given for the NH_4, K, Rb and Cs salts; also for a solid solution of the dihydrogen phosphate and arsenate of ammonia over the complete range of composition. R. O. DAVIES

536.461

6004. The similarity law of flame-propagation. F. SCHULTZ-GRUNOW. *Z. phys. Chem.*, **201**, *No.* 5–6, 211–22 (*Dec.*, 1952) *In German.*

A dimensionless form ω of the flame velocity w ($\omega = w(akc_1)^{-\frac{1}{2}}$ where a = thermometric conductivity, k = reaction velocity constant, and c_1 the molar concentration of one constituent) is expressed in terms of the dimensionless parameters ϕ_1, ϕ_2, ϕ_3 for a bimolecular reaction ($\phi_1 = Qc_1/C\rho T$, $\phi_2 = D/a$, $\phi_3 = c_1/c_2$ where Q = ht. of reaction, C = sp. ht. at const. pressure, ρ = density, T = initial temp., D = diffusivity, c_2 = molar concentration of second constituent). The dependence of ω upon ϕ_1 is deduced from the flame velocities of $H_2 + O_2$ diluted with N_2 and CO_2; data on the effect of ϕ_2 is less extensive, but suggests that ω varies as ϕ_2^{-1}. The same dimensionless parameters may be used to systematize data on upper and lower limits of flame propagation: but when the reaction is not bimolecular, additional parameters are needed. A. SCHOFIELD

536.48

6005. A low temperature bath for constant temperature studies. J. VAJDA AND D. P. HART. *Rev. sci. Instrum.*, **24**, 354–5 (*May*, 1953).

Describes the construction and operation of a bath used for low temperature impact testing. Its simplicity, economical operation, and close temperature control make it applicable to other uses in the field of low temperature studies. A.

536.48

6006. A cryostat for magnetic susceptibility measurements at low temperatures. A. L. SMITH AND H. L. JOHNSTON. *Rev. sci. Instrum.*, **24**, 420–3 (*June*, 1953).

A cryostat is described which provides excellent temperature regulation and control for magnetic susceptibility measurements in the range 78°K to room temperature. Use of the cryostat with both the Faraday test-body method and the Gouy method is described in some detail. A conveniently used thermostating arrangement is capable of maintaining sample temperatures to within $\pm 0{\cdot}1°$ at 115°K over periods of several hours. The method used for the temperature control is of rather general applicability. A.

536.48

6007. A method of concentrating He^3–He^4 mixtures. K. R. ATKINS, J. C. FINDLAY, D. R. LOVEJOY AND W. H. WATSON. *Canad. J. Phys.*, **31**, 679 (*May*, 1953).

The concentration of He^3 in He^4 is increased from 2% to 64% in a single operation. The principle used is that liquid He^4 flows more easily than liquid He^3 through a very small leak. R. O. DAVIES

536.48

6008. Cluster theory of the saturated vapor pressure of helium isotope mixtures. W. BAND AND R. A. NELSON. *Phys. Rev.*, **90**, 744–7 (*June* 1, 1953).

The cluster-avalanche theory of saturated vapour is developed for the two helium isotopes He^3 and He^4, and for mixtures of the two isotopes. Quantum degeneracy is included by using Bose–Einstein and Fermi–Dirac statistics as required by the parity of mass numbers in the clusters. The theory expresses the saturated vapour pressure in terms of the surface energy of clusters. The observed vapour pressures of the two pure isotopes are used to determine the surface energies in pure He^3 and pure He^4 clusters. An interpolation formula for the surface energy of mixed clusters is then found to explain the observed vapour pressures of the isotopic mixtures. The results appear to indicate that He^3 is anomalously reduced in the surfaces of mixed clusters below the λ-point of bulk liquid mixtures of like concentration. Data above $2{\cdot}2°$K are needed before this interpretation can be established. A.

536.48 : 536.7

6009. The thermodynamics of the helium film. O. K. RICE AND B. WIDOM. Letter in *Phys. Rev.*, **90**, 987 (*June* 1, 1953).

By using the data on film thickness to estimate the thermodynamic properties of the surface film, it is concluded that films of intermediate thickness undergo a first-order surface phase transition at the λ-point. R. O. DAVIES

536.5

6010. The transfer rate of the liquid helium II fi near zero level difference. G. S. PICUS. Letter *Phys. Rev.*, **90**, 719 (*May* 15, 1953).

A plunger is driven slowly into an open beaker He in a bath. Starting from equal levels inside an outside, it is found at $1{\cdot}71°$K that (*a*) the critical fil transfer rate does not set in until 20 sec after the sta when the head is 0·1 mm of He, (*b*) critical flow the reduces the head to about 0·02 mm, and it remain near this, although the level alters by small step rather than continuously. When the motion of th plunger is stopped, zero head is recovered by a dampe oscillation instead of directly. R. O. DAVIE

536.48 : 539.22

X-ray scattering from liquid helium. *See Abstr.* 625

536.48

6011. Hydrogen liquefier for the Scientific Research Institute. M. P. MALKOV AND A. B. FRADKOV. *Zh. tekh. Fiz.*, **22**, *No.* 3, 436–45 (1952) *In Russian.*

Describes the design of a hydrogen liquefier working on the Joule–Kelvin principle using a nitrogen pre cooling bath. It is designed to liquefy about 8 litres an hour and takes about 40 minutes to commence operation. Hydrogen is purified from ordinary commercial electrolytic hydrogen. J. M. HOUGH

536.52

6012. An instrument for the direct measurement of intense thermal radiation. R. GARDON. *Rev. sci. Instrum.*, **24**, 366–70 (*May*, 1953).

A new type of radiometer is described that is suitable for the measurement of the intensity of thermal radiation in the range of 1–100 cal/cm² sec. The instrument is a simple one. It produces an e.m.f. directly proportional to intensity and can be made to have a time-constant of the order of 0·001 sec. Equations are derived to predict the performance of the instrument, and their results are compared with experimental data obtained from three prototypes. A.

536.532 : 533.6.011.3

6013. An experimental investigation of a temperature recorder of the through-flow type in a high-speed gas stream. N. V. ILYUKHIN AND L. N. NAURITS. *Zh. tekh. Fiz.*, **22**, *No.* 12, 2014–25 (1952) *In Russian.*

The temperature recorder consisted of a Cu-constantan wire (0·3 mm dia.) stretched along the axis of a narrow tube (4 mm int. dia., 15–46 mm long); the tube faces upstream (approx.) to the gas flow and the gas entering it passes along the length of the thermocouple wire and escapes through a hollow member which supports the whole device. It was found that the temperature-recovery coeff. [Abstr. 8142 (1952)] remained constant (= 0·99) for Mach number $M = 0{\cdot}45$ to 0·87 and Reynolds number $Re = 2{\cdot}4$ to $6{\cdot}5 \times 10^5$. No appreciable errors were introduced when the axis of the tube was 13° off the direction of the incident gas stream. A. SCHOFIELD

536.631

6014. Results of investigations at low temperatures. X. Atomic heat of indium between 12° and 273°K. K. CLUSIUS AND L. SCHACHINGER. *Z. angew. Phys.*, **4**, *No.* 12, 442–4 (1952) *In German.*

For Pt IX, see Abstr. 7237 (1952). Presents the

sults of c_p measurements for In from the temperature of liquid H to 0°C. Normal entropy at 25°C evaluated to be 13·88 cal/g-atom. deg. The value is obtained by using correction $c_p - c_v = 3{\cdot}36 \times 10^{-5} c_p^2 T$, and can be represented directly as a function of a certain characteristic Debye temperature θ_D. However, the electron heat $c_e = 3{\cdot}55 \times 10^{-4} T$ cal/g-atom. deg is deducted from c_v, the value of θ_D for $c_v - c_e$ varies only between 125 and 140° for the investigated region of temperature. F. LACHMAN

536.631

6015. T^2 dependence of the low temperature specific heat of boron nitride. A. S. DWORKIN, D. J. SASMOR AND E. R. VANARTSDALEN. Letter in *J. chem. Phys.*, **21**, 954–5 (*May*, 1953).

Describes measurements up to 80°K on a high-purity boron nitride specimen. The specific heat at constant volume is proportional to T^2 up to 60°K, in agreement with a Debye formula for crystals with layered (2-dimensional) structure; the Debye temperature is deduced to be 348°K. The results are compared with those of analogous measurements on graphite and gallium. E. P. WOHLFARTH

536.631

6016. The specific heat of solids. G. LEIBFRIED AND W. BRENIG. *Z. Phys.*, **134**, *No.* 4, 451–68 (1953) *In German.*

A theoretical study. The lattice specific heat is expressed as a combination of Debye and Einstein terms. The characteristic parameters of the energy spectrum are derived from lattice theory. Central forces as well as volume forces (due to the valency electron distribution) are considered, the latter enabling deviations from the Cauchy relations between the elastic constants to be included. Calculated specific heats are in good agreement with experiment and with values derived from lattice theory for several monovalent metals. The specific heat anomaly of the alkali metals may be explained quantitatively. E. P. WOHLFARTH

536.653 : 535.375.5

6017. The line shift and heat of mixing of solutions of acetone with saturated hydrocarbons. K. SCHÄFER AND H. WOLFF. Note in *Naturwissenschaften*, **39**, *No.* 23, 547–8 (1952) *In German.*

The "first heat of solution" for acetone/*n*-hexane mixtures, as determined experimentally, tallies very well with the value calculated under certain assumptions from the shape of the curve showing the relationship between the shift of the centre of gravity of the 1708 cm^{-1} CO–Raman line and the mole fraction of acetone. F. LACHMAN

536.658

6018. A new method of determining the partial thermal coefficient of accommodation. K. SCHÄFER AND K. H. RIGGERT. Note in *Naturwissenschaften*, **40**, *No.* 7, 219 (1953) *In German.*

Derives mathematical relationships between the total accommodation coefficients as determined by the combined band-wire method of Eucken–Krome, those measured by the wire method only, and the partial accommodation coefficients for two different degrees of freedom. F. LACHMAN

THERMODYNAMICS 536.7/.8

536.7

6019. Thermodynamic theory of dynamic heating cycles [realized] with refrigerating machines. L. M. ROZENFEL'D. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1334–45 (1952) *In Russian.*

An adaption of the normal refrigerating machine, operating on ammonia/water mixture, is proposed for operating a heat pump on the work obtained from a cycle taking heat in from power station condensate water at 25°–30°C, and rejecting it to the outside air at −10° to −15°C in winter. The system may be reversed in summer to act as a refrigerating machine, and can be used to supply heat and cold simultaneously. R. C. MURRAY

536.7

6020. Theory of refrigerating machines having combined cycles. L. M. ROZENFEL'D. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1346–55 (1952) *In Russian.*

Thermodynamic analysis shows that a "cold absorption" refrigerating machine comprises a heat engine coupled to a refrigerating cycle, and its thermodynamic efficiency is the product of the efficiency of the former and the coeff. of performance of the latter. The operation of such machines should be analysed by comparing each of these cycles separately with ideal cycles; they are less efficient than the combination of a separate heat engine with a compressor refrigerator, both parts operating on a solution (e.g. of ammonia in water). The latter are in turn less efficient than a combination of a steam engine with a refrigerator using a single component (ammonia, freon, etc.) as its working substance. However, refrigerators having combined cycles (without compressors) are thermodynamically more efficient than other types when the heat source has a variable and relatively low temperature (waste gases, hot water, etc.) and when used for the simultaneous production of heat and cold. R. C. MURRAY

536.7

6021. Thermodynamic functions from Mayer's theory of ionic solutions. I. Equations for thermodynamic functions. J. C. POIRIER. *J. chem. Phys.*, **21**, *No.* 6, 965–72 (*June*, 1953).

For an ionic solute, Mayer has previously derived from statistical mechanics an analytical expression for a mean activity coefficient which, however, is not usually measured. From the partial molal free energy expression defining Mayer's activity coefficient, there are derived in this paper expressions for five usually measured thermodynamic functions. These are: the change in partial molal volume with concentration; the change in apparent molal volume with concentration; the relative partial molal heat content; the relative apparent molal heat content, and the stoichiometric mean ionic molar activity coefficient. Formulae for these five functions involve the coefficients of thermal expansion and isothermal compressibility of the solution and solvent; the solvent dielectric constant and its pressure and temperature derivatives, and readily computable analytic expression arising from the theory. A.

536.7

6022. Thermodynamic functions from Mayer's theory of ionic solutions. II. The stoichiometric mean ionic molar activity coefficient. J. C. POIRIER. *J. chem. Phys.*, **21**, 972–85 (*June*, 1953).

The formula for the stoichiometric mean ionic molar activity coefficient of strong electrolytes in aqueous solution at 25°C arising from Mayer's theory is compared with published experimental data. The agreement is good for sodium chloride to a concentration of about 0·4 molar; calcium chloride to a concentration of about 0·07 molar; zinc sulphate to a concentration of about 0·01 molar; and lanthanum chloride to a concentration of about 0·017 molar. Tables facilitating the computations and practical methods for the determination of the parameter of closest interionic approach and of the activity coefficient are given. A.

536.7 : 536.48

6023. Thermodynamic analysis of irreversible low-temperature processes. I. Theoretical concepts and bases of a generalized method of analysis. I. P. ISHKIN AND V. M. BRODYANSKIĬ. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1773–82 (1952) *In Russian.*

To remedy deficiencies in the existing methods for thermodynamic treatment of low-temperature processes, new parameters are defined as follows: the work capacity $B = H - T_0S$ ($\Delta B = \Delta H - T_0\Delta S$); the coeff. of thermodynamic reversibility ψ = incoming work-convertible energy W^+/outgoing work-convertible energy W^-; the coeff. of thermodynamic non-steadiness, $\delta = (W^+ - W^-)/W^+$; and the coeff. of work-convertible heat $K_T = (T_i - T_0)/T_i$. ψ is compared with the thermodynamic efficiency η for various machines and two methods for calculating W^+ and W^- are given. A general method of analysis of the consumption of energy in a low-temperature process is given, which involves splitting it into the reversible part (ΔB) and the irreversible part $D = W^+ - W^-$, and leads to the calculation of the statistical "energetic weight" $\theta i = W^+/\Sigma W_i^+$ for each element of the process. A plot of B against H is given for air, with isothermals for temperatures between 90 and 310°K, isobars for 1–200 atm., and isentropic lines for $S = 0$ to $S = 0{\cdot}9$ g.cal/g°K, and it is shown that many calculations are more conveniently carried out with this than with the conventional T–S and H–S diagrams. R. C. MURRAY

536.7 : 536.48

6024. Thermodynamic analysis of irreversible low-temperature processes. II. Analysis of separate irreversible processes in low temperature technology. I. P. ISHKIN AND V. M. BRODYANSKIĬ. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1783–93 (1952) *In Russian.*

Formulae are deduced for calculating the coeffs. of thermodynamic reversibility ψ and of thermodynamic non-steadiness δ for (*a*) compression of gases and liquids; (*b*) cooling of a gas by throttling, expansion in an engine or through a vortex tube; and (*c*) heat exchange, and the various processes are analysed in terms of these quantities, using B–H diagrams ($B = H - T_0S$) for the cases examined under (*a*) and (*b*). For the expansion of a gas in an engine, and index derived from ψ and expressed terms of changes of B is a better measure of t approximation of the process to adiabatic conditio than the usual "adiabatic efficiency" based upo changes in H. The calculation of the efficiency heat exchangers as the ratio of the heat actual transferred to the maximum possible, favoured b many authors, is correct only at very low temperature and should be replaced by the value of ψ, calculate as the ratio of the changes in B of the two bodi exchanging heat with one another. R. C. MURRA

536.7 : 537.312.6

6025. Thermodynamics and superconductivity. M. LAUE. *Z. angew. Phys.*, **4**, *No.* 12, 458–9 (1952) *German.*

The thermodynamics of the phase equilibrium c superconductors in a magnetic field lead, above th threshold field, to a possible configuration whic consists of a system of superconducting and norma domains. As this is in contradiction to experimenta evidence an interfacial surface energy has bee postulated which would make such configuration thermodynamically unstable (H. London, 1935) V. Laue points out that this assumption is unnecessary because thermodynamics cannot predict the actua occurrence of a thermodynamically possible configura tion. The fact that such structures actually do occu in the intermediate state prior to the final destructio of superconductivity is not considered. H. LONDON

536.71 : 518.5

6026. Equation of state calculations by fast computing machines. N. METROPOLIS, A. W. ROSENBLUTH, M. N. ROSENBLUTH, A. H. TELLER AND E. TELLER. *J. chem. Phys.*, **21**, 1087–92 (*June*, 1953).

A general method, suitable for fast computing machines, for investigating such properties as equations of state for substances consisting of interacting individual molecules is described. The method consists of a modified Monte Carlo integration over configuration space. Results for the two-dimensional rigid sphere system have been obtained on the Los Alamos MANIAC and are presented here. These results are compared to the free volume equation of state and to a four-term virial coefficient expansion. A.

536.71 : 530.162

TFD functions for non-zero temperatures and equations of state based on them. *See Abstr.* 5869

536.75

6027. Empirical function for the calculation of the normal entropy of gases and vapour forming compounds. G. GEISELER. Note in *Naturwissenschaften*, **39**, *No.* 24, 569 (1952) *In German.*

A development of Werner's equation for the normal entropy of gases and vapours (S^0_{298}), in which a general expression is found for the entropy in terms of molecular weight and number of atoms in the molecule. Comparison between calculated and experimental values for predominantly linear molecules shows good agreement. Alteration of one constant in the equation gives better agreement for spherical or disk-shaped molecules as well as for monatomic gases. F. E. HOARE

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.226.2 : 621.317.335.3

6028. On the theory of permittivity measurement in the centimetre range. N. V. KOTOSONOV. *Zh. tekh. Fiz.*, **22**, *No.* 3, 530–6 (1952) *In Russian.*

The theory of the standing wave method for measuring dielectric constant is developed for H_{01} waves in a waveguide and various arrangements of two dielectric slabs and a short-circuit. J. M. HOUGH

537.226.2 : 621.317.335.3 : 621.315.612.4

6029. Problem of the dielectric characteristics of ferroelectrics. R. I. YANUS. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1256–61 (1952) *In Russian.*

Properties of ferro-electrics should be investigated by methods allowing for their analogy with ferro-magnetic materials—methods for ordinary dielectrics are not sufficient. Various measuring methods may give not only different numerical values of the permittivity of ferro-electrics, but reveal also different physical aspects of this property, differing by their physical sense. Details of the use of a ballistic galvanometer method for permittivity measurement are given. J. LUKASZEWICZ

537.226.2

6030. Dielectric polarization in polar substances. F. E. HARRIS AND B. J. ALDER. *J. chem. Phys.*, **21**, 1031–8 (*June*, 1953).

A statistical mechanical theory of the static dielectric constant of polar substances is presented which differs from the previous theories of Kirkwood and Fröhlich in that a precise evaluation of the distortion polarization term is made. The theory is applied to the dielectric constant of ordinary and heavy water and yields 2% agreement with experiment over the entire temperature range. Furthermore, the difference between the dielectric constant of water measured at visible and microwave frequencies can be ascribed to vibrations, such as the bending of the O–H–O bond. The calculated dielectric constant of ice agrees with experimental values within a mean deviation of 3% over a considerable temperature range using an approximate evaluation of the Pauling model for that substance. Various other liquids are also compared with experiment. A.

537.226.2

6031. Refractive index of dipolar gas mixtures at decimeter wavelengths. R. SCHACHENMEIER AND F. WELLER. Note in *Naturwissenschaften*, **40**, *No.* 1, 17–18 (1953) *In German.*

At 17 000 Mc/s air/water vapour mixtures have additive polarizations above 150 mm Hg at 290°K, but below this total pressure increase of effective relaxation time gives lower polarizations.

D. H. WHIFFEN

537.226.2 : 537.311.33 : 621.317.335.3 : 621.317.374

6032. On the new method of measuring dielectric constant and loss angles of semiconductors. B. ICHIJŌ. *J. appl. Phys.*, **24**, 307–11 (*March*, 1953).

A double resonant circuit is described which can be used for measuring the loss angles of very lossy materials in the range 2–10 Mc/s. Both the shunt capacitance and resistance of the specimen are measured in terms of capacitor changes. A theory and description of the measuring method are given. A comparison is made between measurements by this and the single resonance method on a conducting rubber. W. T. BLACKBAND

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.1 : 539.11

6033. Correlation between variations of density and electronic conductivity during the melting of substances with diamond or zincblende structure. N. P. MOKROVSKIĬ AND A. R. REGEL'. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1281–9 (1952) *In Russian.*

Results are tabulated and graphed of measurements of densities and thermal expansion coefficients for Ge, GaSb, InSb, HgSe, and HgTe, in both solid and liquid state. Correlations have been found for the variations of density and electrical conductivity during the melting of these substances. Results of measurements confirm the assumption that the nature of short-range order (hence that of the bond forces, too) determines the electrical properties of substances in both solid and liquid state. F. LACHMAN

537.311.3

6034. The surface electric conductivity of glasses in damp atmosphere. N. G. GUTKIN, K. S. EVSTROP'EV AND A. YA. KUZNETSOV. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1318–24 (1952) *In Russian.*

The surface electric conductivity of glasses in damp atmosphere increases by 1 to 5 times as compared with their conductivity in dry atmosphere. At a given temperature, increasing the dampness of the atmosphere results in an increase of surface conductivity; the largest increase takes place when the dampness changes between 30 and 80%. The surface conductivity rises with rise in temperature, the temperature coefficient in the region of high humidity for individual glasses varies between 2 and 4%. The increase of surface conductivity of glasses in damp atmosphere is explained as a result of formation on the glass surface of a very thin film of electrolyte solutions arising from the electrolysis of silicates of surface glass and the subsequent adsorption processes occurring in the silicon surface layer of the glass.

Z. F. WOJNAR

537.311.3

6035. Conductivity measurements on the system Bi_2O_3–CdO. K. HAUFFE AND H. PETERS. *Z. phys. Chem.*, **201**, *No.* 3–4, 121–30 (*Dec.*, 1952) *In German.*

The temperature dependence of the electrical conductivity has been investigated for $Bi_2O_3 + x\%$ CdO ($0 \leqslant x \leqslant 50$) and for CdO + $y\%$ Bi_2O_3 ($0 \leqslant y \leqslant 10$) in the temperature range 300°–550°c. Deficit conduction is inferred for ambient oxygen pressures in excess of 10^{-2} mm Hg, and excess conduction for pressures below this value. P. T. LANDSBERG

537.311.31

6036. The extra-resistivity owing to vacancies in copper. P. JONGENBURGER. Letter in *Phys. Rev.*, **90**, 710 (*May* 15, 1953).

The extra resistivity due to vacancies in copper has been calculated to be $1{\cdot}3\times10^{-6}\,\Omega$ cm per atomic per cent vacancies, and is thus of the same order as the extra resistivity due to Ni in Cu. P. T. LANDSBERG

537.311.31 : 536.212.2

6037. Diffusion on the Fermi-surface and the conductivity of metals. M. TODA. *J. Phys. Soc. Japan*, **8**, 339–42 (*May–June*, 1953).

Transport phenomena in metals, such as electrical and thermal conductivity, are treated as a kind of diffusion of electrons on the Fermi-surface. Grüneisen's well-known formula is gained for the electrical conductivity σ, and for the thermal conductivity κ the expression

$$\kappa = \sigma T \frac{\pi^2}{3}\left(\frac{k}{e}\right)^2 \Bigg/ \left[1+\left(\frac{\theta}{T}\right)^2\left(\frac{K}{q_0}\right)^2 \frac{\int_0^{\theta/T} \frac{x^3\,dx}{e^x-e^{-x}}}{\int_0^{\theta/T} \frac{x^5\,dx}{(e^x-1)(1-e^{-x})}}\right]$$

is obtained. In this equation θ denotes the Debye temperature, and K and q_0 are the maximum wave numbers of electrons and phonons respectively. A.

537.311.33

6038. The distribution of the concentration of the current carriers in the Hall effect in a semiconductor. A. I. ANSEL'M. *Zh. tekh. Fiz.*, **22**, *No.* 7, 1146–53 (1952) *In Russian.*

Theoretical. Ioffe has suggested that the concentration of holes and electrons in a semiconductor can change significantly in the Hall effect. Welker's treatment [Abstr. 7872 (1951)] is criticized and a new analysis is given showing that if the change in concentration on the faces of the specimen can be measured then the coefficient of either volume or surface recombination could be found. A. L. MACKAY

537.311.33

6039. On the theory of mixed semiconductors. O. MADELUNG AND H. WELKER. *Z. angew. Phys.*, **5**, *No.* 1, 12–14 (1952) *In German.*

Formulae for the various electrical properties are developed for various types of semiconductor in the conditions where mixed or intrinsic conduction becomes apparent. C. A. HOGARTH

537.311.33

6040. Radiative transitions in germanium. J. B. GUNN. Note in *Proc. Phys. Soc.* [*London*] *B*, **66**, 330–1 (*April*, 1953).

An independent observation of the radiation emitted as a result of hole-electron recombination in germanium. C. A. HOGARTH

537.311.33

6041. Is there a thermal disordering process with germanium? K. SEILER, D. GEIST, K. KELLER AND K. BLANK. Note in *Naturwissenschaften*, **40**, *No.* 56–7 (1953) *In German.*

Experiments on the high temperature therm conversion of *n*- to *p*-type germanium are discusse but the mechanism remains uncertain. C. A. HOGAR

537.311.

6042. On the semiconducting properties of t systems potassium-antimony, caesium-antimony, pott sium-indium, caesium-indium. R. SUHRMANN AN C. KANGRO. Note in *Naturwissenschaften*, **40**, *No.* 137–8 (1953) *In German.*

Thin films were examined and showed resistan maxima corresponding to KSb and K_3Sb; both the compounds and the corresponding In compoun exhibited high-temperature negative resistanc temperature coefficients and other semiconducti features. Activation energies were 0·79, 0·88 a 0·56 eV (intrinsic) for K_3Sb, KSb and Cs_3Sb, a 0·23 and 0·16 eV (impurity) for K_3Sb and Cs_3S respectively. C. A. HOGAR

537.311.

6043. Contact noise in semiconductors. R. BURGESS. Letter in *Proc. Phys. Soc.* [*London*] *B*, 334–5 (*April*, 1953).

Refers to Macfarlane's (1950) theory of curre noise in semiconductors. The result for the long th strip-shaped patch may be expressed in simple clos form; the result for the circular patch is in error a the corrected form is indicated. C. A. HOGAR

537.311.

6044. Mobility of holes and electrons in hi electric fields. E. J. RYDER. *Phys. Rev.*, **90**, 766 (*June* 1, 1953).

The field dependence of mobility has been det mined for electrons and holes in both germanium a silicon. The observed critical field at 298°K beyo which μ varies as $E^{-\frac{1}{2}}$ is 900 V/cm for *n*-type ge manium, 1400 V/cm for *p*-type germanium, 2500 V/c for *n*-type silicon, and 7500 V/cm for *p*-type silicc These values of critical field are between two and fo times those calculated on the basis of spherical co stant energy surfaces in the Brillouin zone. A satur tion drift velocity of 6×10^6 cm/sec is observed germanium which is in good agreement with pr dictions based on scattering by the optical mod Data on *n*-type germanium at 20°K show a range ov which impurity scattering decreases and the mobili increases with field until lattice scattering dominat as at the higher temperatures.

537.311.

6045. High field mobility in germanium with i purity scattering dominant. E. M. CONWELL. *Phy Rev.*, **90**, 769–72 (*June* 1, 1953).

Experimental measurements show a variation mobility with electric field intensity of electrons *n*-type germanium which differs at 20°K from th observed in the same specimen at 77°K and high temperatures. This difference can be accounted f by scattering by ionized impurities. A crude quan tative treatment is carried out along the lines Shockley's treatment for the case of lattice scatteri As in that case, the resulting theory fits the data w if the rate of energy loss is taken several times high

than that given by the theory assuming that the surfaces of constant energy are spherical. A.

537.311.33

6046. Space-charge limited emission in semiconductors. W. SHOCKLEY AND R. C. PRIM. *Phys. Rev.*, **90**, 753–8 (*June* 1, 1953).

A situation analogous to thermionic emission into vacuum can occur in semiconductors. A semiconductor analogue for a plane-parallel vacuum diode may consist of two layers of *n*-type semiconductor bounding a plane-parallel slab of pure semiconductor. The current density analogous to Child's law is $J = 9\kappa\varepsilon_0\mu V^2/8W^3$, where κ = dielectric constant, ε_0 = m.k.s. permittivity, μ = mobility, V = applied voltage, and W = thickness of pure region. The condition prevailing at the space-charge maximum is analysed taking into account diffusion due to random thermal motion. Brief discussions are given of the effect of fixed space charge, the dependence of mobility upon electric field strength and the role of space-charge limited emission in a new class of unipolar transistors. A.

537.311.33

6047. Space-charge limited hole current in germanium. G. C. DACEY. *Phys. Rev.*, **90**, 759–63 (*June* 1, 1953).

A situation can arise in semiconductors similar to the space-charge-limited emission of electrons in vacuum. The theory of Shockley and Prim for this phenomenon has been extended to the high-field case using the approximation that the drift velocity of the carriers is $v = \mu(EE_0)^{\frac{1}{2}}$, where μ is the low field mobility, E the electric field, and E_0 the "critical field." For this approximation the current density analogous to Child's law for a plane parallel diode is $J = (2/3)(5/3)^{3/2}K\mu E_0^{1/2}V_a^{3/2}/w^{5/2}$, where V_a is the potential across a diode of thickness w and K is the dielectric constant in m.k.s. units. Good agreement between theory and experiment for hole flow in germanium at liquid air temperature has been obtained, using values of μ and E_0 obtained independently by Ryder. A.

537.311.33

6048. Theory of solid rectifiers. A. I. GUBANOV. *Zh. tekh. Fiz.*, **22**, *No.* 3, 381–93 (1952) *In Russian.*

These are considered to have a thin layer of opposite conductivity type to the bulk. By solving the diffusion equations and Poissons equation, the current-voltage rectifier characteristic is obtained. A numerical example for a copper oxide rectifier gives a curve showing the dependence of rectifier resistance on voltage, in agreement with experiment. W. BARDSLEY

537.311.33

6049. Impurity diffusion and space charge layers in "fused-impurity" *p-n* junctions. J. S. SABY AND W. C. DUNLAP, JR. *Phys. Rev.*, **90**, 630–2 (*May* 15, 1953).

Fused-impurity *p-n* junctions have properties which depend upon alloying and diffusion of impurities. The inverse-voltage space charge distribution in such junctions is found to be such that nearly all the applied potential drop occurs within the base material. The barrier capacitance varies inversely as the square root of the applied voltage as expected for an abrupt transition junction. However, the diffusion of only 2×10^{12} acceptor atoms per cm^2 into *n*-type germanium is found sufficient to include the space charge layer (which includes the region of maximum dielectric stress) entirely below the diffused surface, in the relatively undisturbed base material. Diffusion calculations are reported, based on the latest values of diffusion constants, for various impurities, heating times, and temperatures. These lead to the conclusion that even a few seconds' diffusion time at very moderate temperatures (even below 500°c) is sufficient to result in the diffusion of more than 2×10^{12} atoms of any of the common donors or acceptors. A.

537.311.33

6050. On the changes in contact potential difference of a germanium rectifier during the electrical forming. T. NIIMI. *J. Phys. Soc. Japan*, **8**, 324–30 (*May–June*, 1953).

It has been found experimentally that the change in contact potential difference ΔV_D during the forming process can be determined by observing the variation of a saturation current in the reverse direction with the time required for forming, the values of ΔV_D obtained for three kinds of surfaces ranging from 0·16 V for an etched surface, from 0·06 V to 0·07 V for a cleaved surface, and from $0{\cdot}04_2$ V to $0{\cdot}04_6$ V for a surface exposed to nascent hydrogen. The theoretical treatments have been investigated to explain the experimental results, using the idea of Bardeen's surface levels and assuming that the variations in concentration of donor impurities present in the barrier, which had been caused by the thermal diffusion of acceptor impurities from the surface of the semiconductor, would affect the contact potential difference. Qualitative predictions appear to agree with the results satisfactorily. A.

537.311.33

6051. On the theory of the germanium rectifier and transistor. H. KRÖMER. *Z. Phys.*, **134**, *No.* 4, 435–50 (1953) *In German.*

Because of the exceptionally high fields at semiconductor/metal contacts the appropriate carrier mobility is not the usual value which applies when the potential fall along a mean free path is small compared to kT. In the stronger field the carriers undergo more frequent collisions and thus on the average drift more slowly through the crystal. This "slowing-down" effect (Staueffekt) is dependent on current density and electric field. Because of image force the calculated surface potential rise is then found to vary considerably from the parabolic shape predicted by Schottky. With the reduced surface potential the characteristics of crystal diodes and transistors can be calculated; the high values of current gain are a natural consequence of the model. C. A. HOGARTH

537.311.4

6052. The problem of the conductivity of an electric contact. B. S. GAL'PERIN. *Zh. tekh. Fiz.*, **22**, *No.* 9, 1513–17 (1952) *In Russian.*

The theory of spreading cannot be applied to a point-type or separated contact. Expressions for the

effective area of an electric contact with convex surfaces may be derived on the assumption of possible conductivity mechanisms of gaps of atomic dimensions, viz. the tunnel effect or facilitated emission of thermal electrons. It is found that the current is mainly concentrated in the zone of approach within which the gaps do not exceed 1–1·5 Å, independently of the surface configuration. The calculation also proves that the predominant conductivity mechanism between the metal particles is the tunnel effect. The characteristics of the contact play an essential role in disperse conducting systems. As regards the thermal electron mechanism, the calculation shows that if the work function exceeds 1·5 eV, the tunnel effect will always prevail at the normal temperatures over the thermal electron emission, at least in the interesting range of gap sizes. The apparent predominance of thermal electron emission in the range of very small gaps is only a result of an incorrect application of the theory working with electric image forces to gaps of atomic dimensions, and has no physical significance. However, the actual thermal electron emission influences in certain ranges the temperature relation of the conductivity of the gaps.

B. F. KRAUS

537.312.5

6053. Properties of monocrystalline photo-resistivities of cadmium sulphide when excited by Röntgen rays. S. V. SVECHNIKOV. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1305–14 (1952) *In Russian.*

The photo-resistivities of monocrystals of cadmium sulphide possess great sensitivities in the region of hard ionizing radiation. With properly chosen illumination it is possible to increase the sensitivity of the crystal in the ionizing radiation by 1·5 to 2 times. The photo-resistivity of cadmium sulphide can be successfully utilized on alternating as well as constant currents.

Z. F. WOJNAR

537.312.5

6054. The rise of the variable component in photo-current of photo-cells at large intensities of illumination. L. A. VAĬNSHTEĬN AND L. P. MALYAVKIN. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1315–17 (1952) *In Russian.*

The appearance of the variable audio-frequency component in the photo-current of vacuum and gas-filled tubes is considered at intensities of illumination of the order of 10^5 lux. The a.f. oscillations for vacuum and gas-filled photo-cells lie between 100–5000 c/s and 10–20 kc/s, their amplitude being about 0·1% and 1–5% of the constant value of photo-current, respectively. In certain cases high frequency oscillations are superimposed on a.f. oscillations.

Z. F. WOJNAR

537.312.5

6055. Fundamental investigation of the effect of oxygen on the electric and photoelectric properties of the lead-sulphide photo-resistances. S. M. RŸVKIN. *Zh. tekh. Fiz.*, **22**, *No.* 12, 1930–44 (1952) *In Russian.*

The results of an investigation on the effect of the "reversible" (loosely-bound) O show that, after high-temperature treatment, the PbS layers absorb O vigorously also at ordinary temperature, the absorption being centred in the interstices between the small crystals of PbS. The absorption of O changes the properties not only of the interstices but also of the whole layer, viz. both the electric and photoelectric conductivity increase following the same law. When O is absorbed, the "time constant of photoconductivity" τ increases in accordance with the same law as that obeyed by the increase of photoconductivity itself. The bond energy between O and the layer (interstices) varies from 0·25 to 0·56 eV for the samples tested. The coefficient of diffusion of O in the interstices is *c.* 10^{-10} cm^2 sec^{-1} at 30–40°C, the energy of activation of diffusion being a few tenths of 1 eV.

F. LACHMAN

537.312.5

6056. On the photoelectric and optical properties of a special type of lead sulphide cells. L. GENZEL AND H. MÜSER. *Z. Phys.*, **134**, *No.* 4, 419–24 (1953) *In German.*

537.312.5 : 537.533.72

6057. An electron-optical method of investigating electromagnetic fields and its application to the study of the internal photoeffect. V. S. VAVILOV. *Zh. tekh. Fiz.*, **22**, *No.* 10, 1644–57 (1952) *In Russian.*

A shadow method [see also Abstr. 2566 (1950)] is described, capable of measuring potential changes at the surface of the specimen down to ~0·2 V, the resolution being somewhat better than 1 μ. A p.d. was established between the ends of a PbS strip, illuminated over part of its length, and the variation of potential along it was measured, so that drift of current carriers into the unilluminated region could be determined. Although the specimens showed "hole" dark conduction, most of the photoconduction was due to electrons. The sign of the predominant photoconductive current carriers was confirmed by the condenser method [Abstr. 8748 (1950)]; the change of sign on illumination was confirmed by the observation that, at constant applied p.d., the Hall e.m.f. diminishes with increase of illumination.

J. C. E. JENNINGS

537.312.62

6058. Superconductivity of alloys of bismuth with rubidium and caesium. N. E. ALEKSEEVSKIĬ. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 5 (11) 610 (1952) *In Russian.*

The intermetallic compounds formed in systems Bi–Rb and Bi–Cs become superconducting at 4·25 and 4·75°K, respectively, and show clear transition curves even for very inhomogeneous alloys with large Bi excess. It is thus proved that all the alkali metals form with the metals of the 1st group, and with some metals with an incompletely populated *d*-shell, intermetallic compounds which can become superconductors.

B. F. KRAUS

537.312.62

6059. The energy-momentum tensor in the phenomenological theory of superconductivity. F. BECK. *Z. Phys.*, **134**, *No.* 3, 334–45 (1953) *In German.*

The unsymmetrical energy-momentum tensor introduced by Schubert [Abstr. 6507 (1950)], which was based on the scalar, linear theory, is not the only possible one and leads to consequences in some respects unplausible. In the present paper it is shown how the equations of superconductivity and the resulting energy-momentum tensor can be formulated

in a non-linear, Lorentz-invariant form. The relation between the current density J and the momentum vector $G = \Lambda J$ is left open. The London equation $-c$ curl $G = H$ remains unchanged, but $\partial G/\partial t = E$ becomes $\partial G/\partial t + c^2 \text{ grad}\chi = E$, $\chi = mc/e\sqrt{(c^2 - v^2)}$, where v is the velocity of the electrons. Thus the additional term is relativistically small. The resulting energy-momentum tensor, however, becomes unsymmetrical, at least in the scalar theory. In the non-scalar theory (where Λ is a tensor) it remains unsymmetrical, but this is justified because in this case angular momenta can in fact be exerted on the body. H. LONDON

537.312.62

6060. Some special switching-on and release processes in superconductors. L. A. KÖNIG AND G. V. SCHUBERT. *Z. angew. Phys.*, **5**, *No.* 1, 5–9 (1953) *In German.*

The London equations of superconductivity are extended by a term which takes account of the inertia of the normal electrons. This has the consequence that in processes involving the release of space charges [M. v. Laue, *Theory of Superconductivity*, New York: Academic Press (1952), 19–20] and the sudden switching on of a magnetic field [Abstr. 4995 (1950)] longer relaxation times are obtained. H. LONDON

537.312.62

6061. Do all metals become superconducting? K. CLUSIUS. *Z. Naturforsch.*, **8a**, 214 (*Feb.–March*, 1953) *In German.*

It is suggested that superconductivity and ferromagnetism are mutually exclusive as the former shows $B = 0$ in the interior while for the latter an internal magnetic field is characteristic. H. LONDON

537.312.62

6062. Thermal resistivity of mercury in the intermediate state. J. K. HULM. Letter in *Phys. Rev.*, **90**, 1116 (*June* 15, 1953).

The thermal resistivity of Hg in the intermediate state shows an excess over the value to be expected by linear interpolation between the normal and superconducting states, and the maximum value of this excess is found to be $1{\cdot}3 \times 10^{-3}\,(T_c/T)^5$ watt^{-1} cm. deg. This formula agrees roughly with an interpretation based on the two fluid model. D. SHOENBERG

537.312.62 : 536.7

Thermodynamics and superconductivity. *See Abstr.* 6025

ELECTRIC DISCHARGES 537.52

537.523 : 537.56

6063. Photo-ionization and the electrical breakdown of gases. J. DUTTON, S. C. HAYDON AND F. LLEWELLYN JONES; Mathematical appendix by P. M. DAVIDSON. *Proc. Roy. Soc. A*, **218**, 206–23 (*June* 25, 1953).

A quantitative theoretical investigation is made of the role of photo-ionization of the gas in the development of ionization currents in gases under uniform fields. Using published values of the relevant absorption coefficients and atomic cross-sections, the theory is applied to the case of air, and the results then compared with those previously obtained experimentally. It is shown that photo-ionization can lead to electrical breakdown only under certain restricted conditions which relate the ionization coefficients and atomic cross-sections for photon-molecule interaction; these restrictions are such that there must be considerable penetration of the gas by ionizing photons, and in many cases a high proportion of all the photons can reach the cathode. It is also found that the theoretical curve for the growth of current, obtained on the assumption that photo-ionization is the only operative secondary ionization process, has the same general form as the growth curve based on the other secondary processes, e.g. secondary emission from the cathode; there are, however, significant differences in detail. This quantitative investigation supports the view that photo-ionization does not play a predominant role as a secondary ionization process leading to the electrical breakdown of air at values of $p \times d \sim 760$ cm mm Hg in uniform fields. AUTHORS

537.523.5

6064. Further studies of electrode phenomena in transient arcs. W. R. BLEVIN. *Austral. J. Phys.*, **6**, 203–8 (*June*, 1953).

High current transient arcs in air at atmospheric pressure display radial contraction of the column near the anode. An examination of melting in the anode allows calculation of the anode spot temperature. A.

537.525

6065. Difficulties of a discharge in a magnetic field with a special configuration of the discharge gap. É. M. REĬKHRUDEL', A. V. CHERNETSKIĬ, V. V. MIKHNEVICH AND I. A. VASIL'EVA. *Zh. tekh. Fiz.*, **22**, *No.* 12, 1945–66 (1952) *In Russian.*

Difficulties in the development of a glow discharge in a magnetic field at low gas pressures with a special geometry of the discharge gap were investigated. The electrons are subjected to the simultaneous action of an inhomogeneous electric and an axially symmetrical magnetic field. The external magnetic field controlling the kinetics of the electrons in the systems selected has an effective influence on the ignition potential, current and other parameters of the discharge. The potential distribution in the discharge was measured by the method of double probes. The volt-ampere characteristics of the currents on the cylindrical sonde and on planar probes placed at various points and in different orientations with respect to the current direction were recorded. Oscillograms showed the occurrence of periodical and chaotic oscillations in the plasma. The mechanism of the discharge is discussed, the following results emerging: The magnetic field strongly influences the free path of the electrons and the ionization coefficient α; at low pressures it reduces greatly the ignition potential and increases the discharge current. Some effects of the field in a hampered discharge in various gases may be predicted from Paschen's curves. In Ne, A and air the range of the fall of the VA-characteristics due to the variation of the anode drop in the discharge was determined. Probes

introduced parallel to the axis of the tube leave the discharge practically unaffected, whereas probes at right angles to the magnetic field heavily disturb it. Directional electron and ion currents were observed, and also the absence of a plasma in large sections of the discharge vessel. The distribution of the space charges in the discharge gap could be determined. Effects of an alternating field and of an a.c. supply could also be observed and interpreted. B. F. KRAUS

537.525

6066. The electrical breakdown of gases in non-uniform fields at low pressure. F. LLEWELLYN JONES AND G. C. WILLIAMS. *Proc. Phys. Soc.* [*London*] *B*, **66**, 345–61 (*May*, 1953).

The electrical breakdown of gases between coaxial cylinders at low pressures was studied in air (a gas mixture), hydrogen (a diatomic gas) and in helium (a monatomic gas). The significant secondary ionization processes occurring were correlated with those which are known to occur in uniform fields. The similarity theorem was used to help in the identification of the fundamental collisional processes. The experimental results were consistent with the view that breakdown involves the same primary and secondary ionization processes as in uniform fields: the relative importance of the dominant secondary electron emission processes depends on the nature of the electrodes and the geometry of the system. The effects of traces of impurities in helium were also studied and the results were accounted for by the action of metastable atoms. AUTHORS

537.525 : 537.56

6067. Processes involving ions and metastable atoms in mercury afterglows. M. A. BIONDI. *Phys. Rev.*, **90**, 730–7 (*June* 1, 1953).

Atomic collision processes occurring in mercury vapour are determined from microwave measurements of the electron density during the afterglow. The electrons are brought into thermal equilibrium with the gas by adding helium to the mercury vapour to act as a "recoil gas." Measurements of the ambipolar diffusion coefficient, D_a, of Hg^+ ions and electrons in helium yield the value $D_a n = 2{\cdot}6\times10^{19}$ (cm²/sec) (atoms/cm³) at 290°K. The corresponding value for Hg^+ ions in mercury is $D_a n = 3{\cdot}6\times10^{17}$ at 350°K. Conversion of the atomic mercury ions to molecular ions according to the reaction $Hg^+ + Hg + He \rightarrow Hg_2^+ + He$ occurs at the rate of $140\,(p_{Hg}\cdot p_{He})\ sec^{-1}$. The measured recombination coefficient of Hg_2^+ ions with electrons is $\alpha = 5{\cdot}5\times10^{-7}$ cm³/sec at 400°K. Studies of the ionization produced by the collisions of pairs of mercury metastable atoms yield the values $D_m n = 1{\cdot}5\times10^{18}$ (cm²/sec) (atoms/cm³) for the diffusion coefficient and $\sigma_d = 8\times10^{-17}$ cm² for the de-excitation cross-section of $^3P_2$ metastables at 350°K. A.

537.525.4

6068. On the interpretation of extremely low burning voltages of high frequency discharges between plane plates. F. SCHNEIDER. *Z. angew. Phys.*, **4**, *No.* 9, 324–5 (1952) *In German.*

Discusses the low discharge voltages found at very high frequencies in terms of diffusion phenomena in plasmas. The effect of positive ions on electron diffusion is considered. J. D. CRAGGS

537.52

6069. Current densities of free-moving cathode spo on mercury. K. D. FROOME; H. v. BERTELE. Lette in *Brit. J. Appl. Phys.*, **4**, 91–2 (*March*, 1953).

The first letter points out, with reference to a earlier publication of v. Bertele, that the visib structure of the discharge at the cathode indicat current densities $\sim10^7$ A/cm² flowing into certa discrete areas. The second letter discusses cathoo spots in transient and stable arcs, in relation to th observations of Froome and others, and includes th suggestion that current, at the cathode, also flows i more diffuse areas. J. D. CRAGG

X-RAYS 537.531

537.53

6070. The degree of homogeneity of X-rays. E ZIELER. Note in *Naturwissenschaften*, **39**, *No.* 2 567 (1952) *In German.*

The thickness of aluminium (called the HWS required to absorb half of the X-ray energy indicate the hardness but not the homogeneity of X-rays the HWS of a second absorber is used to give th degree of homogeneity, which is defined as 1s HWS/2nd HWS. A. R. STOKE

537.531 : 535.34

6071. Calculation of the structure of the mai X-ray absorption edge of atoms in molecules. É. E VAINSHTEIN, P. L. BARINSKIĬ AND K. I. NARBUTT *Zh. eksper. teor. Fiz.*, **23**, *No.* 5 (11) 593–608 (1952) *In Russian.*

A method is given for the calculation of the fine structure of the main X-ray absorption edge. This method is used for the interpretation of the X-ray absorption spectra for a number of gas molecules and simple ions in solution. It is shown how the method can be used for determining from the X-ray absorption spectra the constants of the absorbing molecule, such as the ionization potential, polariz-ability and others, and also for registering quanti-tatively the changes in the energy state of the atom which accompany its entry into a chemical bond with the neighbours in the compound. E. RABKIN

537.531 : 535.343.2

6072. Observations on articles by A. I. Kostarev. A. I. KOSTAREV. Letter in *Zh. Eksper. teor. Fiz.*, **23**, *No.* 5 (11) 609–10 (1952) *In Russian.*

More exact calculations of the form of the potential wells surrounding atoms of Cu absorbing X-rays permit diagram 3 of the author's paper [Abstr. 4808 (1949)] to be amended. A later paper [Abstr. 7928 (1951)] also requires this correction. It appears that thermal oscillations do not broaden the potential wells but only make them less deep. A. L. MACKAY

537.531 : 539.166

6073. Polarization of bremsstrahlung radiation. R. L. GLUCKSTERN, M. H. HULL, JR, AND G. BREIT. *Phys. Rev.*, **90**, 1026–9 (*June* 15, 1953).

The dependence of the differential cross-section for bremsstrahlung on photon polarization is calculated in the same approximation as the Bethe–Heitler formula for the sum over polarizations. The

adiation is found to consist of a mixture of an npolarized and a linearly polarized component. he relation of the method of intermediate states to ne method of transitions between stationary states is xplicitly stated. A.

537.531 : 539.166

6074. Polarization dependence of the integrated remsstrahlung cross section. R. L. GLUCKSTERN ND M. H. HULL, JR. *Phys. Rev.*, **90**, 1030–5 (*June* 15, 953).

The differential cross-section for bremsstrahlung lerived in the previous paper (preceding abstract) is ntegrated over the direction of the emerging electron. t is found that regions of appreciable polarization ccur near both the low energy and high energy ends f the photon spectrum. Calculations are performed or the polarization dependence of the radiation for ncident electrons of about 0·1, 0·5, 2·5 MeV with nd without approximate shielding corrections calculated for aluminium. The polarization dependence of the differential cross-section for pair production and of the cross-section integrated over either the electron or positron direction is obtained from the results for bremsstrahlung by the well-known procedure of changes from positive to negative energy state. A.

537.531.08

6075. Measurement of half-value layer for oil-shielded X-ray tubes. E. ZIELER. *Z. angew. Phys.*, **4**, *No.* 8, 293–7 (1952) *In German.*

A 200 kV X-ray set was used. The beam irradiating the measuring chamber was successively collimated by apertures of four sizes, and X-ray transmission curves in Cu show that the beam hardens as the aperture decreases, since less scattered radiation from the oil and metal of the tube-casing is received by the ionization chamber. The effective quality of this scattered radiation is shown to be about the same as that of the unfiltered primary beam. The nature and angular distribution of the scattered radiation are discussed, and the likely error in using a finite beam for measuring half-value layer, is indicated.

D. V. MABBS

537.531.08

6076. Analysis of fluorescent X-radiation by means of proportional counters. R. E. ROWLAND. Letter in *J. appl. Phys.*, **24**, 811–12 (*June*, 1953).

The spectrum produced when an X-ray beam falls on an external Ti target (used for microradiography) is analysed using a large Be-window proportional counter filled at one atmosphere with A and CH_4. The output is recorded on a Brown potentiometer via a motor-driven single-channel analyser. The process is rapid and has also been valuable in tracking down spurious X-rays from collimators. Recorded spectral traces are shown. D. V. MABBS

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

6077. Investigation of the autoelectric emission from a monocrystalline point by means of a spherical electron projector. I. L. SOKOL'SKAYA. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1301–4 (1952) *In Russian.*

A demountable field emission microscope with pressure $< 10^{-6}$ mm Hg was used to study changes in emission pattern of W points (dia. 5×10^{-5} cm) caused by migration of adsorbed gas and vapour atoms on heating the point, with and without applied electric field. Without field, heating gives a non-equilibrium spherical form of point, the adsorbed atoms migrating from regions of higher to regions of lower curvature. On heating with an applied field, migration causes the surface of the point to resemble the equilibrium limit of a monocrystalline cubic system. J. W. MENTER

537.533

6078. On the field emission and work function of individual crystal surfaces. M. DRECHSLER AND E. W. MÜLLER. *Z. Phys.*, **134**, *No.* 2, 208–21 (1953) *In German.*

The Fowler–Nordheim emission equation is generalized to apply to real metal surfaces with crystal faces of varying work function, the required potential function being deduced from model experiments in the electrolytic trough. Summation formulae for the current density and total emission are given. Experimental results on the 011 face of W crystals yield the value $\phi_{011} = 5{\cdot}8$ eV. A. H. W. BECK

537.533

6079. Surface films and field emission of electrons. F. LLEWELLYN JONES AND C. G. MORGAN. *Proc. Roy. Soc. A*, **218**, 88–103 (*June* 9, 1953).

Experimental investigation of the cold electron emission from metals covered with thin ($\sim 10^{-7}$ cm) tarnish films in gases shows that substantial emission ($\sim 10^5$ electrons/sec) can be produced by comparatively low applied electric fields ($\sim 10^4$ V/cm). The results are consistent with the view that the electrons emitted are extracted from the metal substrate by the high electric field set up across the thin surface film when covered with a layer of positive ions, the presence of positive ions on the thin film being essential to the emission mechanism which follows a field law; this high emission does not occur when the thin surface tarnish film is absent. A theory based on this view is given and quantitative agreement with the experimental data is obtained. The implications of these results to the problems of the initiation of electrical discharges in general, including the electrical breakdown mechanism at high gas pressures as well as the initiation of micro-arcs at electrical contacts, are indicated. Comparison of the field emission from a mechanically polished surface with that from an electrolytically polished surface shows that the surface smoothness obtainable by the two methods of polishing can be of the same order.

AUTHORS

537.533 : 537.583

6080. Investigation of the electron emission from a metal in the range of its transition from the cold into the thermionic state. I. S. ANDREEV. *Zh. tekh. Fiz.*, **22**, *No.* 9, 1428–41 (1952) *In Russian.*

An experimental verification of the emission equation in the transition range between cold and thermionic emission was carried out by means of a

spherical "electron projector," by which it was possible to measure the currents from the individual faces of the monocrystalline emitter. A method was also evolved permitting of overcoming the difficulties encountered in determining the field strengths on the emitter. The changes of the form of the emitter during its thermal treatment were also investigated. The work function of the electrons in the crystallographic directions (110) and (111) on a spherical emitter was determined. The theory used was based on that evolved by Guth and Mullin and it was proved that even under the most unfavourable conditions the field strength could be determined with an error not exceeding 2%. As regards the work function for the face (110), the thermal treatment produces values of it which are lower than those found by Nichols (1940), by producing other crystal faces (as "emission spots") superposed on the face (110). Considering all the data obtained, it may be concluded that the true value of the (110) work function must be higher than Nichols's and the author's values. B. F. KRAUS

537.533.72

6081. A retarding field filter for electron diffraction and electron microscopy. H. BOERSCH. *Z. Phys.*, **134**, *No.* 2, 156–64 (1953) *In German.*

A retarding field method is used to eliminate electrons which have suffered inelastic collisions. Photographs illustrate the much improved contrast which results from the insertion of the filter.

A. H. W. BECK

537.533.72

6082. Electron optical properties of electrostatic fields having diad symmetry. A. M. STRASHKEVICH. *Zh. tekh. Fiz.*, **22**, *No.* 3, 487–97 (1952) *In Russian.*

Seman [Abstr. 5436 (1951)] showed for axially symmetric fields that the applicability of the thin lens approximation can be extended if $r\Phi^{1/4}$ is taken as constant instead of r. This is adapted to the present case and integrals are given for the focal length and the magnification in the planes of symmetry. Abstr. 9518 (1951) gave a formula for the potential near the axis of a system of coaxial apertures in electrodes, one of the apertures being elliptical; an improved formula is now given, especially advantageous at small separations of the apertures. From it expressions are derived for the focal lengths. J. C. E. JENNINGS

537.533.72

6083. Basic relations of relativistic electron optics of non-axially symmetric electrostatic fields. A. M. STRASHKEVICH. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1848–56 (1952) *In Russian.*

The discussion is paraxial and the general formulae are applied particularly to cylindrical lenses and to fields of diad symmetry (see also preceding abstract).

J. C. E. JENNINGS

537.533.72

6084. A method for the numerical integration of a class of equations of mathematical physics and its application to electron optical problems. YU. V. VOROB'EV. *Zh. tekh. Fiz.*, **22**, *No.* 7, 1166–73 (1952) *In Russian.*

The class of equations considered is $y'' + yQ(x) = 0$, where $Q \to \infty$ not more rapidly than x^{-2} as $x \to \infty$. A solution is assumed of the form $y = ux^{\rho}$ and with the help of the Newton–Gregory forward interpolati formula the auxiliary function uQx^2 is determined a few points near the singularity. A forward differen extrapolation formula is then used until the solutio has been carried far enough for other well-know numerical methods to be applicable. Details, i cluding numerical coefficients in the extrapolatio formulae, are given for the solution of the paraxi ray equation, in Picht's "reduced" form, for the ca in which the initial electron energy $\to 0$. The metho here proposed differs, e.g. from that of Recknag (1941) in that the latter involves axial derivatives o the potential, which is disadvantageous where th potential is not given analytically. J. C. E. JENNING

537.533.7

6085. Aberrations of electron optical systems wit charged surfaces in the refracting region. O. I. SEMAN *Zh. tekh. Fiz.*, **22**, *No.* 10, 1581–91 (1952) *In Russian.*

The problem relates to proposals to correct aberra tions by means of grids, which are here idealized a curved conducting surfaces, perfectly transparent t electrons. Expressions are derived for the primary aberrations, by the method of the characteristic function, in the formulation of Abstr. 8242 (1952). Distinction is made between two effects of the "grids": (*a*) change of axial potential distribution due to their presence, affecting paraxial and aberrationa properties and (*b*) effects on aberration associated with the curvature of the "grid" surfaces. In an immersion objective the latter effects do not significantly correct spherical aberration. J. C. E. JENNINGS

537.533.72

6086. "Non-optical" theory of focusing in axially symmetric magnetic fields. I. I. TSUKKERMAN. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1843–7 (1952) *In Russian.*

Refers chiefly to the image-converter type of system, with mixed electric and magnetic fields. It is indicated how, given $V(z)$, and also $r(z)$ for rays non-skew at the cathode, the necessary $H(z)$ can be determined to satisfy the condition that an image of the cathode is formed in the plane $z = z_1$. The conclusions of Abstr. 8248 (1952) are accepted, but are said to have been essentially contained in Abstr. 9519 (1951).

J. C. E. JENNINGS

537.533.72

6087. Image defects in the electron microscope. H. WESTERMANN AND G. PFEFFERKORN. *Z. wiss. Mikr.*, **61**, 270–5 (*March*, 1953) *In German.*

Some of the factors which influence the correct interpretation of electron images in the electron microscope are discussed. The distortion in some types of replica, halo formation and the disintegration which occurs as a result of electron bombardment are illustrated. The photographs emphasize the need for the correct choice of beam intensity, especially with biological materials. H. J. H. STARKS

537.533.74 : 537.534.74

6088. Evaluation of particle loss due to multiple scattering in foils. W. C. DICKINSON AND D. C. DODDER. *Rev. sci. Instrum.*, **24**, 428–31 (*June*, 1953).

A graphical integration method is described for the determination of the fraction of a parallel beam of charged particles which is scattered out of a detector

hen a foil is interposed before the detector. For the se of circular foils and detectors with common rmal axes a generalized graph of percentage particle ss is given which illustrates that, although the loss ay be quite large, rather small variations of the perimental parameters can greatly reduce it. A.

537.533.75

089. On the absorption of electrons and positrons. . KOESTER, H. MAIER-LEIBNITZ AND K. SCHMEISTER. . *angew. Phys.*, **5**, *No.* 1, 9–11 (1953) *In German.*

It is shown experimentally that the absorption of positrons in aluminium is of the same order as the bsorption of electrons in aluminium, but that it is ss for positrons if copper or gold are used as bsorbents. The effect is shown to be in agreement ith a simple theory. P. T. LANDSBERG

537.533.8

090. Secondary electron emission of copper–eryllium alloy. S. YOSHIDA, I. TAKEDA, Y. IGARASHI ND H. ARATA. *J. Phys. Soc. Japan*, **8**, 318–23 (*May–une*, 1953).

The surface products of copper–beryllium (0·5, ·5 and 3·0%) alloys treated under various oxygen ressures and temperatures and their secondary lectron emission characteristics are discussed in letail. The results are summarized as follows: 1) Rapid diffusion of beryllium atoms through opper–beryllium alloy begins at 400°c. (2) In order o activate copper–beryllium alloys, they must contain eryllium atoms more than 1·5%. (3) In the activaion process the temperature must be raised to a desired point at pressure lower than 10^{-5} mm mercury in order to prevent the copper from oxidizing, and then oxygen must be added to the tubes at the treatment pressure. (4) The formation mechanisms of beryllium oxide layers treated at 800°c and below 700°c are different from each other. This difference of treatment temperature is responsible for the two different secondary emission characteristics. A.

537.533.9

6091. Radiation by electrons in large orbits. D. R. CORSON. *Phys. Rev.*, **90**, 748–52 (*June* 1, 1953).

By finding the points in the synchrotron magnetic cycle at which the time rate of change of electron orbit radius vanishes, the total electron energy loss per orbit revolution is measured. The results, for electron energies from 205 MeV to 280 MeV, are in excellent agreement with classical electromagnetic theory. The measurements have been extended to 318 MeV with reduced precision by observing orbit shrink rates after the radiofrequency accelerating voltage is removed. No coherent energy losses and no significant energy losses other than radiation have been observed. A.

537.534 : 621.384.612

6092. On the elimination of alignment defects in the cosmotron with strong convergence. J. SEIDEN. *C.R. Acad. Sci.* [*Paris*] **236**, 1145–6 (*March* 16, 1953) *In French.*

For background see Abstr. 907 (1953). The operating conditions chosen by Courant lead to considerable loss of particles due to alignment errors. By a correct choice of the operating parameters such losses may be much reduced. A. H. W. BECK

537.534.72

6093. Precision mass spectrographs (a comparison of existing apparatus). J. MATTAUCH. *Naturwissenschaften*, **39**, *No.* 24, 557–66 (1952) *In German.*

A brief general discussion of the ion optics of mass spectrometers is given. The ion optics of each existing mass spectrometer is discussed in detail, particular attention being paid to the double focusing property. Tables are given of the resolving power, mass dispersion, line breadth, etc., of these spectrometers. The mass scale and theory of dispersion is discussed. 40 references are given. J. HUGHES

537.534.72

6094. Experimental investigations with an "impulse mass-spectrograph." M. J. HIGATSBERGER. *Z. Naturforsch.*, **8a**, 206–11 (*Feb.–March*, 1953) *In German.*

The theoretical arrangement of Abstr. 6266 (1951) aiming to reduce electric and magnetic scattering fields was confirmed by experiment. Discharge effects in emulsions exposed to the beam were also investigated and improvements are indicated. Absolute mass measurements were made on Li, Na and K. Slow ions which would not blacken the emulsion were registered by means of secondary electrons. The short path length of this spectrograph is suitable for measuring short-lived isotopes. W. J. SWIATECKI

537.534.74

6095. Differential cross-section for elastic *p–p* scattering at 435 MeV. W. E. MOTT, R. B. SUTTON, J. G. FOX AND J. A. KANE. Letter in *Phys. Rev.*, **90**, 712 (*May* 15, 1953).

A significant deviation from isotropy is reported, the values obtained varying from $4{\cdot}49 \pm 0{\cdot}25$ mb/sterad at 25·2° to $3{\cdot}39 \pm 0{\cdot}10$ mb/sterad at 90°, in the centre-of-mass system. J. J. WILKINS

537.534.74

6096. Proton-proton scattering from 1·8 MeV to 4·2 MeV. H. R. WORTHINGTON, J. N. MCGRUER AND D. E. FINDLEY. *Phys. Rev.*, **90**, 899–911 (*June* 1, 1953).

Measurements of the scattering of protons by protons have been made at six energies in the range from 1·8 MeV to 4·2 MeV. At each energy, the differential cross-section was measured as a function of angle from 6° in the laboratory system up to 45° or higher. In the angular range above 20°, the cross-sections are determined to within $\pm 0{\cdot}3\%$. Below 20°, the uncertainties become larger, approaching $\pm 0{\cdot}6\%$ at 6°. Departures from pure *S*-wave scattering are observed at all energies. These deviations are larger than can be explained by the experimental uncertainties. They closely resemble the effect of a negative *P*-wave phase shift of approximately $-0{\cdot}1°$ at 4 MeV and exhibit a reasonable energy dependence. A.

537.534.74

6097. Scattering of protons by protons. H. H. HALL AND J. L. POWELL. *Phys. Rev.*, **90**, 912–14 (*June* 1, 1953).

The data of Worthington, McGruer, and Findley (WMF) on scattering of protons by protons show an apparently real contribution to the cross-section arising from scattering in the *p* state. Results of

phase-shift analysis of these data are presented. A satisfactory fit is obtained in terms of s and p waves only, and there is no evidence for a contribution from higher orbital angular momenta or from p waves of "non-central" character. The s part of the scattering anomaly is analysed in terms of the f function, and substantial agreement with older results is obtained. The energy dependence of the p wave phase shift is consistent with the assumption of a Yukawa force of range $1{\cdot}176\times10^{-13}$ cm, and its magnitude is accounted for tentatively in terms of a combination of "ordinary" and "Majorana" potentials as represented by the factor $(0{\cdot}4+0{\cdot}6P_M)$ in the nuclear Hamiltonian. A.

537.534.74

6098. Proton-proton scattering at 32·0 Mev. B. CORK. Letter in *Phys. Rev.*, **91**, 1129 (*June* 15, 1953).

Further data [Abstr. 342 (1952)] are compared with the calculations of Abstr. 3368 (1953), and the earlier data of Abstr. 8054 (1950).

537.534.75

6099. The stopping of heavy ions in gases. G. E. EVANS, P. M. STIER AND C. F. BARNETT. *Phys. Rev.*, **90**, 825–32 (*June* 1, 1953).

The extrapolated ionization range for the ions He^+, N^+, Ne^+ and A^+ in the stopping gases He, N_2, air and A has been determined as a function of energy in the energy range from ~20 keV to ~250 keV, using mono-energetic heavy ions produced in a Cockcroft–Walton accelerator. A collimated beam of heavy ions is admitted to the range chamber via a three-stage differential pumping system so as to avoid the use of foil windows. The range was determined using a parallel plate ionization chamber mounted so as to permit translation parallel to the axis of the beam. It has been found that the range as measured at a pressure P is not inversely proportional to P, and an interpretation of this pressure effect has been given in terms of large angle scattering of the ions into regions outside of the volume swept out by the ionization chamber. A method of correcting for this pressure effect has been developed and applied to the data to yield range-energy curves which are independent of the ionization chamber size. The space distribution of ionization produced in a gas by a collimated beam of heavy ions has been determined for the same combinations of incident ion, stopping gas, and energy as above. The attenuation of the beam of ions is found to be approximately exponential in the axial direction and approximately Gaussian in the lateral direction. A method has been developed for computing the shape and size of a given ionization density contour at a given pressure if it is known at another pressure and the same energy. A.

537.534.8

6100. The emission of electrons and the reflection of potassium ions from tungsten and tantalum. M. A. EREMEEV AND V. V. SHESTUKHINA. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1267–8 (1952) *In Russian.*

The emission of electrons and the reflection of ions from targets of tungsten and tantalum during irradiation with potassium ions having an energy of from 2 to 6 thousand eV was studied. The target temperature was varied from 293–1200°K and the reflection of ions from 293 to 2000–2500°K. The investigation supports the assumption that the electron emission on the impact of the potassium ion against the surface is associated with the presence of an adsorbed film on the target. E. RABKIN

537.534.8

6101. The emission of electrons and the reflection of lithium ions from tungsten and tantalum. M. A. EREMEEV AND V. V. SHESTUKHINA. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1268–70 (1952) *In Russian.*

The emission of electrons and the reflection of lithium ions from tungsten and tantalum was measured at various temperatures of the target. The energy of the ions was varied from 2 to 6 thousand eV. General results are similar to those obtained using potassium and described in the preceding abstract. Conclusion is as before that an adsorbed film on the surface is connected with emission of electrons. E. RABKIN

537.534.8

6102. The emission of electrons and the reflection of ions of potassium and lithium from oxidized tungsten and tantalum. M. A. EREMEEV AND V. G. YUR'EV. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1290–5 (1952) *In Russian.*

The emission of electrons and ions from oxide films of tungsten and tantalum were investigated during bombardment with potassium and lithium ions. The energy of the primary beam of ions was varied from 1 to 6 keV. The measurements were carried out at target temperatures ranging from 293 to 2200–2500°K. The data showed that the coefficient of the secondary emission of electrons at low temperatures from the oxidized target has a higher value than for pure surfaces at the same temperatures. When the oxide film of tantalum is bombarded with potassium and lithium ions the electron emission approaches the maximum value at a target temperature of approximately 600°K. For the oxide film of tungsten this value gradually decreases with an increase in the temperature of the target. The oxide film produces no effect at a temperature of approximately 1100°K. At temperatures of 1200–1300°K the emission of electrons approaches zero. The destruction of the oxide film occurs at 1700°K, after which the coefficient of the reflection of ions is the same as for a pure surface. The value of the coefficient of the reflection of ions of lithium is smaller and is practically independent of the temperature of the target. The maximum value of the secondary particles in the low temperature region is 15–20 eV. Complete description of the effects observed is given. E. RABKIN

537.534.8

6103. The emission of electrons and the reflection of potassium ions from the surface of liquid tin. M. A. EREMEEV AND T. L. MATSKEVICH. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1296–300 (1952) *In Russian.*

Measurements were made of the emission of electrons and of the reflections of potassium ions from liquid tin at various states of the surface. During similar measurements on solid targets with various surface conditions it was found that the role of the crystalline lattice is of considerable significance; it became of interest to study the electron emission from targets having a different state of aggregation. Tin was chosen because of a low vapour tension and

mparatively low chemical activity. The energy of e bombarding ions was varied from 200 eV to keV. For a surface of molten tin it is possible to tain any number of emitted electrons varying from to values characteristic of solid tin, depending on e purity of the surface. Experiment shows that on e surface of liquid tin no absorption film is pro- iced from the beam of ions at an intensity of $^{-8}$–10^{-6} amperes. E. RABKIN

DISCHARGE TUBES . COUNTERS 537.54

537.542

104. Pig ion source. C. F. BARNETT, P. M. STIER ND G. E. EVANS. Note in *Rev. sci. Instrum.*, **24**, 94–5 (*May*, 1953).

Describes a Phillips Ionization Gauge type ion ource designed for experiments on the stopping of eavy ions in gaseous matter with a Cockcroft–Walton accelerator. It has been used for both aseous and solid type feed materials and gives ion urrents in excess of one milliampere. J. M. HOUGH

537.542

105. Testing the satisfactory operation of Geiger–Muller counters and scalers. P. W. DE LANGE. *S. African J. Sci.*, **49**, 308–10 (*May*, 1953).

A method is presented by which it is possible to etermine whether a counting apparatus is behaving onsistently or not. The method is based on the ifferent properties of two different estimates, V_S nd V_R of the percentage error of the count-rate. V_R is very sensitive to counting errors, but V_S is not. t is shown that if $V_R \simeq V_S$ it is highly unlikely that he apparatus is counting incorrectly. If $V_R > V_S$ t is probable that the apparatus is faulty—the robability increases with the difference $V_R - V_S$. Experimental observations in support of these con- lusions are presented. A.

537.542 : 621.387.42

106. Extending the efficient range of G–M counters. N. C. PORTER. *Nucleonics*, **11**, 32–6 (*March*, 1953).

The mechanism of the discharge in G.M. counters s discussed, and the methods which have been devised o reduce the dead time are reviewed. A two-valve ut-off circuit, which limits the discharge and reduces he inoperative time to 1·5 μsec, is described.

L. R. SHEPHERD

537.542

107. Improvement in response of 4π gamma-onization chambers. C. C. SMITH AND H. H. SELIGER. *Rev. sci. Instrum.*, **24**, 474 (*June*, 1953).

This note describes a chamber operating in atmo- spheric pressure air. Graphs are given to show the effect of spatial variations of source (Co^{60}) position.

J. D. CRAGGS

537.542

6108. Large liquid scintillation detectors. C. L. COWAN, JR, F. REINES, F. B. HARRISON, E. C. ANDERSON AND F. N. HAYES. Letter in *Phys. Rev.*, **90**, 493 (*May* 1, 1953).

Designs for large volume liquid scintillators are described (2 ft^3 to 10 ft^3). Metal tanks are used for the various solutions tried. Banks of 32 to 90 photo-multiplier tubes are used to detect emission. The system is insensitive to source position and counts 75% of 0·5 MeV γ-radiation. The development of the counter is for attempts to detect the neutrino [see Abstr. 5112 (1953)]. G. F. J. GARLICK

537.542

6109. Energy resolution of γ-radiation up to 18 MeV by sodium iodide scintillation counters. J. G. CAMPBELL AND A. J. F. BOYLE. *Austral. J. Phys.*, **6**, 171–89 (*June*, 1953).

The pulse-height distributions to be expected from scintillation counters using thallium-activated sodium iodide crystals have been investigated for γ-radiation of energies 6, 12 and 18 MeV with two sizes of cylindrical crystal (2·5 cm long by 2·5 cm dia. and 7·5 cm long by 4 cm dia.). A Monte Carlo calculation of the partial shower process by which photons are absorbed in the crystals has given the probability distributions of ionization energy from homogeneous incident photons. The spreading of the distributions by statistical effects in the photomultiplier has been measured using light flashes of constant integrated intensity from a rotating mirror. The curves predicted by combining these two factors are compared with experimental pulse-height distributions for γ-radiation from proton bombardment of fluorine, boron and lithium. It is concluded that energy resolution above 10 MeV is severely limited by broadening of peaks introduced by an appreciable and variable fraction of the energy of each incident photon escaping from the crystal as bremsstrahlung. This could be minimized by use of crystals with dimensions large compared with 8 cm, the maximum mean free path of bremsstrahlung photons in sodium iodide. A.

537.542 : 539.166.08

6110. Two-crystal gamma-ray scintillation spectrometer. R. E. CONNALLY. Note in *Rev. sci. Instrum.*, **24**, 458–9 (*June*, 1953).

A spectrometer for use in the region 0·2 to 1·3 MeV is described. The spectrometer crystal A is partially surrounded by a guard crystal which detects radiation scattered from A. By operating the two crystals in anticoincidence, the continuum of pulses due to Compton effect is reduced by ~50%. J. J. WILKINS

537.542 : 621.318.572

6111. Method giving stability and equality of intervals in a pulse-height selector. H. GUILLON. Letter in *J. Phys. Radium*, **14**, 128–9 (*Feb.*, 1953) *In French.*

Based on the principle due to Wilkinson [Abstr. 7325 (1950)]. The pulse to be monitored charges a condenser and the magnitude of the pulse is measured by the number of equal quantities of electricity required to discharge the condenser to its initial condition. The iterative discharge process is carried out by a "diode pump." The output of the circuit is a train of pulses equal in number to the "strokes of the pump" necessary for discharge. This pulse train is recorded in a conventional manner. Pulse amplitudes between 5 V and 50 V can be analysed with a discrimination interval variable between 0·1 V and several volts. The interval is stable to $\pm 0{\cdot}2\%$ and the reference level is stable to $\pm 0{\cdot}03$ V. S. C. DUNN

537.542 : 621.318.572

6112. A simple pulse-amplitude analyser for low counting rates. K. KANDIAH. *Nucleonics*, **11**, 24–8 (*March*, 1953).

A condenser is charged through a diode to the peak potential of the amplified input pulse. This potential is then applied to the input of a high-speed self-balancing potentiometer whose pen-driving mechanism is coupled to a 20-segment switch defining 20 counting channels. The pulse is thus recorded in one of the channel registers and is also registered on the recorder-chart. The resolving time of the analyser is 2·5 sec. Relays operate to prevent the pen moving back to zero between pulses and to prevent a second pulse from reaching the peak-voltage condenser while a pulse is being recorded. L. R. SHEPHERD

537.542 : 778.3

6113. Gray wedge pulse-height analysis. W. BERNSTEIN, R. L. CHASE AND A. W. SCHARDT. *Rev. sci. Instrum.*, **24**, 437–44 (*June*, 1953).

A photographic method of pulse-height analysis equivalent in performance to a 50-channel electronic analyser is described. The basic principle is that pulses from the spectrometer amplifier are stretched and then displayed upon the screen of an oscilloscope and photographed through a grey wedge. The experimental error in the determination of counting rates is 5% and absolute activity calibration is easily made. The instrument is compact, semiportable, inexpensive and easy to maintain. A.

537.542 : 621.318.572

6114. A channel-selecting scale-of-50. F. BORELI. *Recueil Trav. Inst. Rech. Struct. Matière* [*Belgrade*] **1**, 69–74 (*July*, 1952) *In French.*

The scaler uses 50 parallel flip-flop circuits, each gating a channel. The successive input pulses switch the gating circuits so that the open channel, at any instant, corresponds to the number of pulses received. The characteristics of the flip-flop circuits used have been investigated as functions of the circuit component values and optimum working conditions are derived. A computing application is noted. A. J. KENNEDY (R)

537.542

6115. On a simple continuous[-ly sensitive] cloud chamber. W. RIEZLER AND R. WERZ. Note in *Naturwissenschaften*, **40**, *No.* 4, 139–40 (1953) *In German.*

A brief description, with photographs of the chamber and of electron and proton tracks, of a continuously sensitive Wilson chamber. J. D. CRAGGS

IONIZATION . THERMIONICS 537.56/.58

537.56

6116. Specific primary ionization of H_2, He, Ne, and A by high energy electrons. G. W. MCCLURE. *Phys. Rev.*, **90**, 796–803 (*June* 1, 1953).

Monoenergetic electrons, magnetically separated from the continuous spectrum of a radioactive β-ray source, are directed through a series of 3 thin-window G.M. counters. A measurement of the efficiency of the first counter by the coincidence method yields information from which the specific primary ionization of its contained gas is calculated. Measurements on H_2, He, Ne and A over the range of incident electron energies 0·2 to 1·6 MeV have been made and the data compared with the Bethe theory of primary ionization. By adjustment of two constants contained in the theoretical formula, it is possible to fit the data for each of the four gases within the experimental uncertainties. The adjusted formulae yield extrapolated values of the specific primary ionization which are fairly consistent with the work of others at lower and higher energies.

537.5

6117. The threshold law for single ionization of atoms or ions by electrons. G. H. WANNIER. *Phys. Rev.*, **90**, 817–25 (*June* 1, 1953).

When an electron hits an atom or ion, it may knock off an electron. This process is fundamental in almost all types of gas discharge. The reaction is endothermic; hence there is a threshold value in the electron energy below which it does not occur. In this paper, the dependence of the yield on the energy just above this threshold is derived. The derivation is not rigorous because it circumvents some of the difficulties of the three-body problem by applying ergodicity, albeit in a weakened form. The result is that, for atoms, the yield rises as the 1·127th power of the energy excess. For ions the exponent lies between this number and unity. A.

537.562

6118. Alpha-particle ionization in pure gases and the average energy to make an ion pair. W. P. JESSE AND J. SADAUSKIS. Letter in *Phys. Rev.*, **90**, 1120 (*June* 15, 1953).

Describes ionization chamber expts. on the subject and gives a tabular comparison, for 14 atomic and molecular gases, with three other recent series of published data. The discrepancies are serious only for He, a gas whose electrical properties are especially dependent on impurities. J. D. CRAGGS

537.565

6119. The mobility of helium molecular ions in helium. S. GELTMAN. *Phys. Rev.*, **90**, 808–16 (*June* 1, 1953).

A theoretical study of the low field mobility of He_2^+ in its parent gas is described. Forces between He_2^+ and He are calculated by means of perturbation theory. Determination of the scattering phase shifts then yields the momentum transfer cross-section as a function of collision energy. Use of the Chapman–Enskog theory of diffusion permits the calculation of the mobility as a function of temperature. The temperature variation of the mobility of He_2^+ observed by Tyndall and Pearce is analysed by means of classical theories, yielding an effective potential for he He_2^+ — He interaction. The discrepancy between theoretical and experimental mobility is ascribed to certain defects in the calculated potential. When account is taken of ionic clustering, the observed temperature dependence is explained on the basis of a simple potential model. A.

537.583

6120. Surface barrier analysis for the highly refractory metals by means of Schottky deviations. W. W. JUENKER, G. S. COLLADAY AND E. A. COOMES. *Phys. Rev.*, **90**, 772–8 (*June* 1, 1953).

The theory for the deviation from the Schottky effect is redeveloped for the thermionic case, using the Herring and Nichols coefficients μ and λ, which are typical of the two reflection regions of the metallic surface barrier. The assumptions of Guth and Mullin are used, but correction of their calculations leads to new results; a method of data analysis based on these results is described. In this method the Guth–Mullin assumptions regarding the form of the barrier are taken as a first approximation to the real case. The method is applied to available experimental data on tungsten, tantalum and molybdenum. One may draw the following conclusions: The outer (λ) reflection region behaves in accordance with the mirror-image law, while the innermost (μ) is field-independent. The phase change suffered by an electron wave crossing the μ-region is less than that computed for the theoretical box model. All three metals studied are mutually similar as regards the potential form in the μ-region. Apparently, it is not yet possible to evaluate the zero-field reflection coefficient from deviation amplitudes; this is probably due to the parabolic approximation used for the λ-region in the theory. A.

COSMIC RAYS 537.591

537.591.1

6121. Ratio of neutral to charged particles in the nuclear interacting component of cosmic rays. K. GREISEN AND W. D. WALKER. *Phys. Rev.*, **90**, 915–20 (*June* 1, 1953).

The ratio of neutral to charged primaries of nuclear interactions having a median primary energy around 10^{11} eV has been measured at 3250-m elevation, the result being $N/C \simeq \frac{3}{4}$. This value indicates a high degree of elasticity in the nuclear collisions from which nucleons of 10^{11} eV emerge. A.

537.591.1

6122. Cloud-chamber observations of the heavy charged unstable particles in cosmic rays. H. S. BRIDGE, C. PEYROU, B. ROSSI AND R. SAFFORD. *Phys. Rev.*, **90**, 921–33 (*June* 1, 1953).

In a series of pictures taken with a multiplate cloud chamber, a number of charged unstable particles considerably heavier than π-mesons was observed, of which some decay at rest (S particles) and some decay in flight ($V^{\pm}$ particles). In each case the charged decay product is a particle of mesonic mass. From the results, which are not yet completely conclusive, it appears that most of the observed events can be explained by the two-body decay of a single kind of particle. The evidence concerning the mass of this particle, its mean life, and the nature of the neutral decay product is discussed, and compared with those of other experimenters. A.

537.591.1

6123. Mass of cosmic-ray mesons at mountain altitudes. G. ASCOLI. *Phys. Rev.*, **90**, 1079–87 (*June* 15, 1953).

Mass measurements of cosmic-ray particles have been carried out by cloud-chamber observations at 3240-meters elevation to determine the relative rate of occurrence of mesons of different types, in particular of μ-mesons of the hard component and of π-mesons produced locally above the apparatus. From momentum and range observations, the mass of individual particles could be obtained with a probable error of 5%, thus allowing accurate resolution between μ- and π-mesons. The results of 48 observations indicate that all of the particles were very probably μ-mesons. The data yield a μ-meson mass value of $207{\cdot}4 \pm 2{\cdot}4$ electron masses, where the probable error includes an estimate of systematic errors. The observed absence of π-mesons in the experiment is in agreement with the results of observations in photographic plates. In addition, a single cloud-chamber observation was obtained which suggests the existence of a particle having a positive charge twice the elementary charge and a mass roughly equal to that of a nucleon. Alternative interpretations of the observation are discussed in detail. A.

537.591.15

6124. An example of multiple meson production observed with a high pressure hydrogen filled cloud chamber. O. KUSUMOTO, S. MIYAKE, K. SUGA AND Y. WATASE. Letter in *Phys. Rev.*, **90**, 998–9 (*June* 1, 1953).

Discusses a shower observed in a cloud chamber filled with 99% hydrogen and 1% nitrogen at 100 atm. pressure operated at 2740 m altitude. The shower originates in the gas of the chamber and is interpreted as an example of multiple meson production in hydrogen by the process $p + p \rightarrow p + n + \pi^+ + \pi^- + \pi^+$. H. ELLIOT

537.591.5

6125. Constancy of cosmic ray flux over the past 30,000 years. J. L. KULP AND H. L. VOLCHOK. Letter in *Phys. Rev.*, **90**, 713 (*May* 15, 1953).

Possible changes in the cosmic-ray intensity over the past 30,000 years have been investigated by dating deep sea core samples of mud using the ionium and carbon-14 methods and it is concluded that the intensity has not changed by more than 10 or 20% during this period. H. ELLIOT

537.591.5

6126. Cosmic radiation intensity-time variations and their origin. I. Neutron intensity variation method and meteorological factors. J. A. SIMPSON, W. FONGER AND S. B. TREIMAN. *Phys. Rev.*, **90**, 934–50 (*June* 1, 1953).

An experimental method has been developed for extending the study of primary cosmic radiation intensity variations v. time to the low-energy portion of the primary particle spectrum by measuring the nucleonic component intensity within the atmosphere. It is pointed out that this extension of intensity variation observations to the low energies now makes it possible to determine the energy dependence of primary intensity variations as well as to determine the intensity variations with time. The possibility of

determining acceleration, perturbation or injection processes within the solar system as the origin of intensity-time variations is considered. A phenomenological outline of kinds of intensity variations with definitions is presented and their relation to the present studies are discussed. The detector system is a pile structure of lead and paraffin within which the rate of local neutron production is measured by $B^{10}F_3$ proportional counters. Details on the large geomagnetic latitude effect of the nucleonic component or local neutron production are discussed. The quantitative problem of relating intensity-time variations outside the atmosphere to pile neutron production deep in the atmosphere has been treated for primary energies below ~15 BeV for protons and ~7 BeV per nucleon for nuclei of $Z > 1$. In particular, the contributions of primary protons and α-particles to the neutron yield in a pile are considered. The general problem of variations (*a*) due to primary intensity changes, (*b*) due to geomagnetic field variations, and (*c*) due to changing meteorological conditions are considered for nucleonic component measurements. The atmospheric pressure coefficient α is essentially constant over the geomagnetic latitude range $\lambda = 0°$ to $\lambda > 54°$N and for atmospheric depths >600 g-cm^{-2} (mountain altitudes or lower). $\alpha = -(0{\cdot}94 \pm 0{\cdot}03)$ per cent/mm Hg. The difficulties in determining α due to accidental correlations with primary intensity variations is discussed, and a modified method for computing α is illustrated. The effect of atmospheric temperature variations upon observed pile neutron intensity is evaluated by a study of the upper limit contributions which π and μ mesons make as links in the nucleonic cascade. The evidence, including a two-month temperature-cosmic-ray intensity correlation study, indicates a negligibly small local or atmospheric temperature coefficient for the nucleonic component. Pile designs are given both for a simple pile standard which may be constructed anywhere for inter-calibration of experiments and for a 12 counter pile which produces ~7000 counts per minute at $\lambda = 48°$ and altitude 680 g-cm^{-2}. Details are presented on the associated instrumentation. At the present time continuously operating piles are located at geomagnetic latitudes $\lambda = 0°$, 29°N, 42°N, 48°N and 52°N in the geographic longitude interval 75°–106°W. A.

537.591.8

6127. High energy nuclear interactions in lead and light elements. M. F. Kaplon, D. M. Ritson and W. D. Walker. Letter in *Phys. Rev.*, **90**, 716 (*May* 15, 1953).

A block of 92 400 μ stripped emulsions followed by 25 3 mm Pb plates interspaced with 250 μ emulsions was flown for 6 hr in a balloon. A study of the development of showers indicates an initial multiplicity of 20 shower particles for energies $\sim 2 \times 10^{12}$ eV. Seven stars found in emulsions show no dependence of the multiplicity (~ 16) on the number of heavily ionizing prongs (0 to 15). W. J. Swiatecki

537.591.8

6128. On the splitting of heavy nuclei in cosmic rays. K. Gottstein. Note in *Naturwissenschaften*, **40**, *No.* 3, 104–5 (1953) *In German.*

The frequency of fragments plotted against Z as deduced from plates exposed by Dainton *et al.* 1951 at 29 km and $\lambda = 55°$ confirms the discrepa between Dainton *et al.* and Bradt and Peters (19 1952) regarding the frequencies of Be and B. Fr the energy spectrum it can be deduced that ~20% all fragments arriving at the plates arose in splitting of heavier nuclei within the atmosphere.

W. J. Swiatec

MAGNETISM 538

538.1

6129. Magnetic field of a finite solenoid. P. Kunin and I. M. Taksar. *Latv. PSR Zināt. Akad. Vēstis*, **1951**, *No.* 9, 1473–82. *In Russian.*

Magnetic field of a solenoid of finite length calculated on the assumption that current density constant within an infinitely thin layer on the surfa of the solenoid and its component along the solenoid axis is equal to zero. The solution is a functio involving full elliptical integrals. J. Lukaszewic

538.22 : 538.

6130. Measurements on ferrite cores of high permeability. II. M. Kornetzki, J. Brackmann J. Frey and W. Gieseke. *Z. angew. Phys.*, **4**, *No.* 1 371–4 (1952) *In German.*

For Pt I, see Abstr. 5562 (1951). Describes measure ments of the alternating current losses of nickel–zin ferrite specimens. The loss angle δ due to magneti after-effect was measured as a function of frequenc up to 100 Mc/s. Minimum loss curves were obtaine by suitable heat treatment and composition changes it is found that, independently of permeability, th minimum loss angle is given by $\tan \delta \simeq 0{\cdot}07$.

E. P. Wohlfarth

538.221

6131. Antiferromagnetism. R. Ochsenfeld. *Z angew. Phys.*, **4**, *No.* 9, 350–60 (1952) *In German.*

A review of the magnetic, thermal and structura properties, the results of neutron diffraction experi ments and the theory of antiferromagnetism. Ferri magnetism is also discussed. 42 references.

E. P. Wohlfarth

538.221

6132. Neutron diffraction studies of antiferromagnetism in manganous fluoride and some isomorphous compounds. R. A. Erickson. *Phys. Rev.*, **90**, 779–85 (*June* 1, 1953).

Neutron diffraction studies of MnF_2, FeF_2, CoF_2 and NiF_2 are reported. At low temperatures each compound showed the superlattice structure characteristic of antiferromagnetism. The data are accounted for with a magnetic cell of the same dimension as the chemical unit cell; the moments of the magnetic ions at the lattice corners being antiparallel to the moments of the body centred ions. The alignment of the magnetic moments is along the tetragonal axis in all cases except NiF_2 where the alignment direction makes an angle of about 10° relative to the c axis. The intensity of the magnetic scattering as a function of sample temperature follows a Brillouin curve of the form suggested by Van Vleck. Extrapolating the saturation data to zero peak intensity gives the Néel

mperatures for threshold antiferromagnetism. hese are MnF_2—75°K; FeF_2—90°K; CoF_2—50°K; NiF_2—83°K. A.

538.221

6133. Energy absorption in ferromagnetic resonance. A. Young, Jr and E. A. Uehling. Letter in *Phys. Rev.*, **90**, 990–1 (*June* 1, 1953).

Reports measurements of the energy absorption in a thin ferromagnetic sample (nickel, Supermalloy) forming one wall of a resonance cavity, with the constant magnetic field parallel and perpendicular to its plane. Values of $Q_\perp/Q_\parallel$ are deduced and compared with theoretical values based on the concept of the permeability tensor and two different theoretical models (Bloch, Landau and Lifshitz), good agreement being found with the Bloch model. E. P. WOHLFARTH

538.221

6134. A neutron diffraction study of magnesium ferrite. L. M. Corliss, J. M. Hastings and F. G. Brockman. *Phys. Rev.*, **90**, 1013–18 (*June* 15, 1953).

Neutron diffraction patterns have been obtained for polycrystalline magnesium ferrite. Application of a suitably oriented strong magnetic field has made possible a separation of the coherent scattering into its nuclear and magnetic parts. The magnetic scattering is found to be in good agreement with the Néel model of ferrimagnetism. The form factor for the magnetic scattering is found to be, within experimental error, identical with that previously obtained in the case of nickel ferrite. Analysis of the nuclear scattering permits a simultaneous determination of the degree of inversion, which for the specimen used was $0{\cdot}88 \pm 0{\cdot}01$, and the u space group parameter to which the value $0{\cdot}381 \pm 0{\cdot}001$ was assigned. A.

538.222

6135. Paramagnetic resonance in some manganese salts. D. J. E. Ingram. Letter in *Proc. Phys. Soc. [London] A*, **66**, 412–14 (*April*, 1953).

Experimental results are reported obtained at room temperature and at a wavelength of 1·25 cm on $(Mn–Mg)(CH_3COO)_2 . 4H_2O$, $(Zn–Mn)(HCOO)_2 . 2H_2O$ and $(Mn–Mg)(NH_4)_2(SO_4)_2 . 6H_2O$. These results are analysed in terms of the usual Hamiltonian. L. PINCHERLE

538.222

6136. Antiferromagnetic structure in Cr_2O_3. B. N. Brockhouse. Letter in *J. chem. Phys.*, **21**, 961–2 (*May*, 1953).

Describes neutron diffraction measurements on powdered Cr_2O_3 specimens at 22° and −193°C. The magnetic structure is deduced from the measurements and it is found that the magnetic moments of the Cr atoms have roughly the value associated with spin $\frac{3}{2}$ and quenched orbital contribution. E. P. WOHLFARTH

538.222

6137. Paramagnetic resonance in manganese formate. D. J. E. Ingram. Letter in *Phys. Rev.*, **90**, 711 (*May* 15, 1953).

538.222

6138. Proton magnetic resonance absorption in cetyl alcohol. S. Kojima and S. Ogawa. *J. Phys. Soc. Japan*, **8**, 283–7 (*May–June*, 1953).

The line shape of the proton absorption in cetyl alcohol was studied with an autodyne receiver between room temperature and the melting point. The second moment was calculated from recorded derivative curves. The obtained second moment had a hysteresis effect. When the temperature was raised from room temperature, the second moment was almost constant at about 18·5 gauss^2 and it decreased abruptly to the value of 8 gauss^2 near the melting point. When the temperature was lowered from the melting point the second moment kept a small value till the transition point and then increased. The large second moment seems to be due to the monoclinic state and the small second moment to the hexagonal state. It was observed that the resonance line had a fine structure at its centre. A.

538.222

6139. Nuclear magnetic resonance experiment on the single crystals of $K_2HgCl_4 . H_2O$ and $K_2SnCl_4 . H_2O$. I. J. Itoh, R. Kusaka, Y. Yamagata, R. Kiriyama, H. Ibamoto, T. Kanda and Y. Masuda. *J. Phys. Soc. Japan*, **8**, 287–92 (*May–June*, 1953).

Proton magnetic resonances of water molecules in the single crystals of $K_2HgCl_4.H_2O$ and $K_2SnCl_4.H_2O$ were observed, and the distance and the direction of proton-proton line in each of the water molecules in the unit cell were determined. The absorption lines are generally composed of four component lines, of which the separation varies with the direction of the externally applied magnetic field. These results are fairly well explained by Pake's formula for the two-proton system and by the fact that there are two different p–p directions in these crystals. The p–p distance in a water molecule determined in this experiment is 1·607 Å, and the angles between the a-axis and p–p lines which lie on the plane parallel to the c-plane are $\pm 21{\cdot}4°$ for Hg-salt, and 1·62 Å and $\pm 39{\cdot}5°$ respectively for Sn-salt. Each component line has further fine structures when the external field is applied to some particular directions. This cannot be explained by the assumption of a two-spin system only, but by introducing the assumption of a four-spin system. A.

538.222

6140. Nuclear magnetic resonance experiment on the single crystals of $K_2HgCl_4 . H_2O$ and $K_2SnCl_4 . H_2O$. II. The resonance absorption due to four proton system and the revised determination of their crystal structures. J. Itoh, R. Kusaka, Y. Yamagata, R. Kiriyama and H. Ibamoto. *J. Phys. Soc. Japan*, **8**, 293–301 (*May–June*, 1953).

The energy levels and the transition probabilities are calculated for four proton interaction. The result is applied to the case of the single crystals of $K_2HgCl_4 . H_2O$ and $K_2SnCl_4 . H_2O$. Ten absorption lines are expected from the theoretical calculation, of which each five form a group. Since in general cases the separations between the lines belonging to one of these groups are small compared to the separation between these groups as a whole, the expected resonance figure roughly coincides with the case of two proton resonance. But the shapes of resonance peaks have further fine structures. The observed fine structures were analysed and agreement between theory and experiment found satisfactory, if the distance of main

protons is taken to be 1·607 Å, and the distance between the proton-proton lines for adjacent water molecules which are parallel with each other to be 3·60 Å in the case of Hg-salt and 1·62 Å and 3·90 Å respectively in the case of Sn-salt. From these results, the positions of the oxygen atoms in the crystal lattice may be determined with a few assumptions, and the probable space group of $K_2SnCl_4 . H_2O$ will be $V_h^9 - Pbam$ which is identical to that of $K_2HgCl_4 . H_2O$, contrary to the previous X-ray determination. A.

538.222 : 532.13

6141. Nuclear magnetic relaxation in viscous liquids. R. L. CONGER. Letter in *J. chem. Phys.*, **21**, 937 (*May*, 1953).

Presents graphed results of an investigation on the effective magnetic moment (representing the effectiveness of a given ion in decreasing the proton relaxation time) as a function of viscosity. The paramagnetic ions investigated (Cu^{++}, Mn^{++} and Cr^{+++}) have been found to cause different effects. Water/glycerol and water/corn-syrup solutions were used as solvents. F. LACHMAN

538.222 : 539.152.2

6142. The nuclear electric quadrupole moments of copper 63, 65. B. BLEANEY, K. D. BOWERS AND R. S. TRENAM. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 410–12 (*April*, 1953).

See Abstr. 9605 (1951). Further work on the h.f.s. of the paramagnetic resonance spectrum of $CuK_2(SO_4)_2 . 6D_2O$ has revealed considerable departures from axial symmetry and a study of the rhombic component of the anisotropy has been made. The Cu^{2+} spectra have also been observed at 20°K in $La_2Cu_3(NO_3)_{12} . 24D_2O$ which shows a smaller departure from axial symmetry. By assuming as mean value of r^{-3} that which fits most accurately the magnetic h.f.s. data, the values $-0·15_7$ and $-0·14_5 \times 10^{-24}$ cm² were obtained for the electric quadrupole moments of the isotopes 63 and 65. L. PINCHERLE

538.23

6143. Change of shape of the hysteresis loop of transformer sheet steel during magnetic creep. R. FELDTKELLER. *Z. angew. Phys.*, **4**, *No.* 8, 281–4 (1952) *In German.*

After application of a weak alternating field the loop changes to a "butterfly" shape (cf. Perminvar), returning to its initial shape after several hours at room temp. The phenomenon is due to the appearance of transient harmonic oscillations, in antiphase to the steady oscillations and influencing the statistical distribution of the Barkhausen discontinuities in the material. E. P. WOHLFARTH

538.23

6144. The complex permeability of a ferrite core of high permeability. R. FELDTKELLER AND O. KOLB. *Z. angew. Phys.*, **4**, *No.* 12, 448–51 (1952) *In German.*

Gives a qualitative analysis of the curves giving μ_L as a function of μ_R for a range of values of the frequency (0–10 Mc/s) and for several values of the field strength (0–16 mA/cm) for a Ni–Zn ferrite specimen. The influence of the Jordan after-effect, the electrical and mechanical resonance and the magnetic hysteresis is discussed. E. P. WOHLFARTH

538.23 : 538.2

6145. A relation between the Jordan hysteresis constant and the initial permeability [of ferromagnetic media]. M. KORNETZKI. *Z. angew. Phys.*, **4**, *No.* 343–5 (1952) *In German.*

A discussion showing that the ratio h/μ of different ferromagnetics ($h = \nu/\mu$ in Rayleigh's law $B = \mu H + 2\nu H^2$) is proportional only to the reciprocal of the saturation induction. This result is verified approximately by measurements on Ni–Zn ferrites having widely differing μ values but values of h/μ differing only slightly from each other.

E. P. WOHLFARTH

538.2

6146. Bitter figures on 3% Fe–Si alloys. G. SOMMERKORN. Note in *Naturwissenschaften*, **40**, *No.* 219–20 (1953) *In German.*

The different domain structures existing in 3½% Fe–Si after demagnetization in different ways are shown up by Bitter patterns. A. E. DE BARR

538.245 : 539.22

Electron microscopical investigations of ferromagnetic domains. *See Abstr.* 6260

538.247

6147. On the question of determining the retentivity of non-uniformly magnetized specimens. A. I. BULANOVA, M. H. MIKHNEVICH AND V. B. PERETTS. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1325–33 (1952) *In Russian.*

An experimental and theoretical investigation has been made of the ballistic method of measuring retentivity. The two samples were of identical shape but one had been annealed and two different methods of changing the field were used: (1) the removal of the field, (2) the reversal of the field. The results obtained experimentally varied with the distance apart of the specimens and the relative diameter of the specimen and coil. This is explained on the assumption that the magnetization of the specimen is such that it behaves like a magnetic ellipsoid and it is shown that the method of removal of the field produces a value which is a characteristic of the material and not the geometry. J. M. HOUGH

538.247

6148. Cyclic adiabatic demagnetization. S. C. COLLINS AND F. J. ZIMMERMAN. Letter in *Phys. Rev.*, **90**, 991–2 (*June* 1, 1953).

Reports the success of a device which maintains the temperature of a sample at 0·73°K while the heat sink is at 1·13°K. R. O. DAVIES

ELECTROMAGNETISM . ELECTRODYNAMICS
538.3/.5

538.3

6149. The general validity of Planck's formulation of the law of the inertia of energy. F. BECK. *Z. Phys.*, **134**, *No.* 2, 136–55 (1953) *In German.*

By the addition of the energy momentum tensor for matter to Minkowski's tensor for the electromagnetic field, difficulties arising from the unsymmetrical character of the latter tensor can be removed [see Abstr. 830 (1951), 8947 (1952)]. The case of an

ectromagnetic field in an isotropic uncharged sulator is discussed in detail. R. A. NEWING

538.521 : 621.3.011.5

.50. Electric induction in polarized matter. L. ARTRE. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **3**, 81–90 *Feb.*, 1953) *In French.*

The familiar relationship for a dielectric medium $= E + 4\pi P$ is derived using the conception that ectrons are particles of definite size rather than in rms of a continuous distribution of electricity. A efinition of the flux is proposed and the manner in hich the polarization vector is determined by the lectric field is discussed. Some observations are lso made by A. Liénard in an appended note.

A. E. KAY

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561

6151. Plasma oscillations in crossed electric and magnetic fields. A. I. AKHIEZER AND R. V. POLOVIN. *Zh. tekh. Fiz.*, **22**, *No.* 4, 1794–1802 (1952) *In Russian.*

The interaction of an electron beam with slow electromagnetic waves in crossed constant electric and magnetic fields represents a difficult mathematical problem owing to the complicated structure of the h.f. field of the slow waves and the influence of the source charge of the beam. Not only are the calculations very laborious, but they also fail to reveal the influence of the individual factors on the interaction between electrons and h.f. field. A simplifying assumption for investigating the h.f. variations of speed and density of the electron beam is that the constant charge and current of the beam are compensated by charge and current of heavy ions which themselves do not take part in the h.f. oscillations. The retarding medium and the beam are assumed as infinite in order to avoid having to solve boundary problems. The problem then reduces to finding the conditions in which the steady movement of the electrons at right angles to the common plane of electric and magnetic field vectors, representing the elementary case, becomes unsteady, i.e. results in fluctuations of speed and density which eventually become infinite, either in time or space; these two distinct cases are defined as "generation" and "amplification," respectively. These cases are completely analysed and the dispersion equation solved for the interesting extreme cases, the solutions being physically discussed or interpreted. B. F. KRAUS

538.565 : 621.396.622

6152. An ultra-high-frequency discriminator. G. RAOULT AND R. FANGUIN. *C.R. Acad. Sci.* [*Paris*] **236**, 1143–5 (*March* 16, 1953) *In French.*

The input and transmitted signal of a resonant cavity are compared in phase by feeding to the E and H branches of a waveguide "magic T" and a resulting error signal proportional to $d\omega$ is amplified and fed to the klystron reflector: a stabilization factor of 1100 is obtained. If modulation is introduced in the amplifier a stabilized frequency modulated signal is obtained. D. H. WHIFFEN

538.566

6153. Reflection coefficients for certain rough surfaces. V. TWERSKY. Letter in *J. appl. Phys.*, **24**, 659–60 (*May*, 1953).

The scattering of e.m. waves from perfectly conducting surfaces composed of either semi-cylindrical or hemispherical bosses on a smooth plane is found by equating the scattered energy resulting from unit area of incident wave with the energy "missing" from unit area of wave reflected at the specular angle. The same results are obtained analytically.

R. W. FISH

538.566

6154. A rigorous treatment of the diffraction of electromagnetic waves at a slit. R. MÜLLER AND K. WESTPFAHL. *Z. Phys.*, **134**, *No.* 3, 245–63 (1953) *In German.*

The boundary conditions are reduced to an integral equation for the electric field in the plane of the slit, following Levine and Schwinger's procedure [Abstr. 1842 (1949)]. A development of the kernel of the equation in powers of ka (k = wave number; a = width of slit) gives in principle an exact solution. Calculations were carried out numerically up to terms in $(ka)^4$. The calculated field at large distances from the slit and the slit transmission coefficients are in agreement with experiment. The relation of the present treatment to previous ones is discussed.

L. PINCHERLE

538.566 : 535.312 : 534.24

Total reflection of waves from a point source. *See Abstr.* 5926

538.566.2 : 551.594.221

6155. On the propagation along the earth's surface of very long electric waves and the lightning discharge. W. O. SCHUMANN. *Z. angew. Phys.*, **4**, *No.* 12, 474–80 (1952) *In German.*

A detailed mathematical derivation is given of the steps leading to the conclusions previously reported in Abstr. 1787 (1953). R. H. GOLDE

538.566.3 : 621.396.11

6156. A review of v.h.f. ionospheric propagation. M. G. MORGAN. *Proc. Inst. Radio Engrs*, **41**, 582–7 (*May*, 1953).

Although the very high frequencies (30–300 Mc/s) are allocated for utilization almost entirely upon the premise that propagation will be tropospheric, there are very definite ionospheric effects with which one must reckon. These are: (1) regular F_2 ionization; (2) sporadic E ionization; (3) scattering from regular ionization; (4) auroral ionization; (5) meteoric ionization. The first of these is predictable with reasonable accuracy and provides phenomenally good communication over great distances and with extremely low power. The second is far less predictable, but can also provide good communication with extremely low power. The third is mainly a newly discovered phenomenon; although it offers possibilities for regular communication, several serious problems arise. The fourth and fifth are so far only of nuisance value to the communicator, but of great interest to the geophysicist. The nature of v.h.f. propagation arising from these sources of ionization is discussed. The maximum distance

between path terminals for single-hop propagation is about 2400 km for reflection from *E*-region effects and about 4000 km for *F*-region effects. Multiple hops are rarely significant except from the regular F_2 ionization at frequencies only slightly above 30 Mc/s. Much information is included on the nature of the ionization as deduced from the propagation effects. A.

MAGNETIC EFFECTS 538.6

538.652

6157. Experiments on the partial changes of magnetostriction [in ferromagnetic media]. E. BAILITIS, C. HAGEN AND H. H. RUST. *Z. angew. Phys.*, **4**, *No.* 8, 284–91 (1952) *In German.*

Describes experiments showing that the magnetostrictive changes of length of a ferromagnetic specimen may be analysed into several contributions corresponding to the reversible and irreversible elementary magnetization processes. E. P. WOHLFARTH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

6158. A statistical theory of order–disorder equilibrium at high temperatures. P. SCHWED AND G. GROETZINGER. *J. chem. Phys.*, **21**, 963–4 (*June*, 1953).

An expression for the free energy of a binary cubic alloy undergoing the order–disorder transition is derived by direct evaluation of the configurational partition function. A.

MOLECULAR STRUCTURE 539.13

539.13

6159. The dissociation energy of fluorine by the explosion method. E. WICKE AND H. FRIZ. *Note in Naturwissenschaften*, **39**, *No.* 22, 522 (1952) *In German.*

Igniting electrically a F_2–H_2 mixture (with or without additional gases) inside a steel sphere, the explosion-detonation boundary, depending on the H_2 content, was determined. The dissociation energy was found as $37{\cdot}0 \pm 2$ kcal/mol. J. JACOBS

539.13

6160. The forces between hydrogen molecules. A. A. EVETT AND H. MARGENAU. *Phys. Rev.*, **90**, 1021–3 (*June* 15, 1953).

Earlier calculations of the $H_2 - H_2$ interaction, based on the use of screening-constant functions, seemed to lead to reasonable answers only with the use of a nuclear charge much greater than the correct value for the isolated molecule, $Z_0 = 1{\cdot}166$. The present work is a recalculation of the exchange forces for $Z = Z_0$. A small numerical error in the earlier work is eliminated, and the exchange ener instead of being slightly negative as reported pr viously, is actually positive. This removes all pr plexing features from the problem and yields resu in substantial agreement with experiments. The to interaction, consisting of exchange, van der Waa and quadrupole energies, is plotted for differe relative orientations of the molecules. A weight average over all orientations is shown and compar with the semi-empirical curve of Hirschfelder, Bi and Spotz, which was derived by fitting viscosity da

539.1

6161. Separation of the intramolecular and inte molecular contributions to the second moment of th nuclear magnetic resonance spectrum. E. R. ANDRE AND R. G. EADES. Letter in *Proc. Phys. Soc.* [*Londo A*, **66**, 415–17 (*April*, 1953).

The evaluation of molecular parameters from th second moment is often difficult because the exac crystal structure is not known at the temperature c the experiment. Here a method is developed for th estimation of intramolecular contribution witho knowledge of crystal structure. The second momen is measured for two isotopic species of the sam compound. Then the intramolecular contributio can be expressed as a function of these moments an the factors by which the intra- and inter-molecula contributions are reduced in the isotopic species The method was applied to benzene, at 80°K, as th crystal structure is only known at higher temperature As isotope 1.3.5 $D_3 C_6 H_3$ was used. The intra molecular contribution was found to be $3{\cdot}16 \pm$ 0.17 gauss. The side of the molecular hexagon was calculated ($2{\cdot}487 \pm 0{\cdot}022$ Å). This is the sum of the CC and CH bond lengths, and it agrees well with other evaluations. At 130°K similar measurements were carried out. The method can be applied to molecules where all the protons of the non-deuterated molecule are equivalent, as in such cases the factors appearing in the formula can be evaluated statistically. A. J. TAYLOR

539.132

6162. The nonadditivity of the repulsive potential of helium. P. ROSEN. *J. chem. Phys.*, **21**, 1007–12 (*June*, 1953).

The repulsive energy of three helium atoms is calculated using the valence bond method. A great reduction of the required number of exchange integrals is found to be possible using group theoretical arguments. It is found that the effect of nonadditivity is negligible for the internuclear distances involved in most physical problems. A.

539.132

6163. Symmetry factoring of the kinetic and potential energy matrices. B. CRAWFORD, JR. *J. chem. Phys.*, **21**, 1108–9 (*June*, 1953).

In computing the kinetic-energy matrix for vibrations of large molecules of useful symmetry, a tedious double matrix multiplication is usually involved. A theorem is presented, replacing this by a shorter calculation, which may be used either to save labour or to check the result. A.

539.132

64. Unified orbital theory of the excited states of e fluorine molecule. C. R. MUELLER. *J. chem. iys.*, **21**, 1013–17 (*June*, 1953).

The unification of the atomic orbital and molecular bital theories of the excited states of diatomic molecules is achieved by means of semi-localized orbitals. n particular the classification of the states of the uorine molecule arising from the interaction of two uorine atoms in their ground state is discussed. uantitative calculations are made for the $^3\Sigma_g^+$ and Σ_u^+ states and a comparison of the singlet-triplet eparation energies and binding energies from the ree methods is made. Both two-electron and ighteen-electron calculations are made. The better olecular orbital calculations give a lower triplet han a singlet state. In the eighteen-electron calculation the atomic and semi-localized orbital methods oincide, and the $^1\Sigma_g^+$ state is found to be the ground tate. A.

539.133 : 535.343.4–14

The microwave spectrum and structure of ozone. *See Abstr.* 5957

539.133 : 535.343.9

Absorption spectrum of free HCO radicals. *See Abstr.* 5964

539.133 : 535.435

A light scattering investigation of the polymolybdates. *See Abstr.* 5984

539.133 : 537.226.2

6165. The reaction field of a noncentral dipole B. K. P. SCAIFE. Letter in *J. chem. Phys.*, **21**, 945–6 (*May*, 1953).

An alternative derivation of the formula of Frood and Decker [Abstr. 6491 (1952)]. D. H. WHIFFEN

539.133 : 535.435

Angular distribution of the light scattered by random coils. *See Abstr.* 5985

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

6166. Beta-decay and the shell model, and the influence of collective motion on nuclear transitions. A. BOHR AND B. R. MOTTELSON. *Physica*, **18**, 1066–78 (*Dec.*, 1952).

A review is given of the various evidence on nuclear structure derived from β-decay data, with a discussion of the extent to which this evidence can be interpreted on the basis of the shell model. A model is then considered which recognizes collective motion as well as single particle motion as the fundamental types of motion in the nucleus: the average nuclear field itself is recognized as a dynamical variable. This model is applied particularly to a discussion of the analogue, in nuclei, of the Frank Condon principle for molecules, of the breakdown of selection rules and of the radiation properties of the surface. L. PINCHERLE

539.152.1

6167. On a new selection rule possible for certain β-disintegrations. M. TROCHERIS. *Physica*, **18**, 1094–6 (*Dec.*, 1952) *In French*,

A selection rule slowing down transitions in which a re-arrangement of more than one particle occurs is discussed in relation to the difficulties of the simple shell model in accounting for the *ft* values of Zr^{89m}, Y^{87} and Cd^{115m}. W. J. SWIATECKI

539.152.1

6168. On the dilatational oscillations of nuclei. G. MARX. Note in *Naturwissenschaften*, **39**, *No.* 20, 476–7 (1952) *In German.*

The energies of l-pole compressive oscillations of a spherical drop are deduced. The case $l = 2$ gives $E \sim 60\,A^{-\frac{1}{3}}$ MeV, which could explain the observed γ resonances. W. J. SWIATECKI

539.152.1

6169. The energy levels and the structure of light nuclei. D. R. INGLIS. *Rev. mod. Phys.*, **25**, 390–450 (*April*, 1953).

A theoretical interpretation of the energy level sequences of the light nuclei of the p-shell is developed, in the spirit of an exploratory survey. Phenomenological assumptions concerning the nuclear forces are used and the secular problem of intermediate coupling (between the Russell–Saunders and (jj) extremes) is in most cases treated by means of rough interpolations, so no exact energy agreement can be expected, but the order of states of various quantum numbers in the p-shell configuration can be approximately established. This order and the general density of levels agree with the observations, so far as they have been made, in enough cases to give some evidence for the validity of the general method of approach, though further refinements are needed. Subjects treated are: The meaning of nuclear models; the phenomenological approximations to the specific nuclear forces and various possible sources of the spin-orbit coupling; well-established wave-mechanical fundamentals of two-body (as an example of many-body) systems; the relation between symmetry and energy for two electrons or two neutrons; the relation of the total isobaric spin quantum number T to the more directly physical dynamical variables of a system of nucleons; the experimental data for the various polyads, or groups of isobars, arranged in such a way as to make apparent the matching in energy of the states of the same T but different neutron excess, after a correction has been applied for Coulomb energy differences; the theory of intermediate coupling in atoms, and the application to nuclei; the interpretation of the energy level sequences observed in the various polyads, from $A = 5$ to $A = 17$, as well as some of the methods that have been used for making the crucial experimental assignments of angular momentum and parity of the various states; the degree of partial success of the interpretation leaves the impression that the (jj)-coupling scheme of heavy nuclei gives way to intermediate coupling in the light nuclei, and that some of the higher order deviations from this scheme may usefully be described as a partial transition to the nucleon clustering of the alpha-model in a few nuclei whose atomic number A is especially

favourable for this clustering; Coulomb energy calculations; the remarkable appearance of double levels (which look like atomic doublets but are explained differently) in some of the nuclei near $A = 30$, beyond the formal scope of this paper; the possible role of the alpha-model in influencing the states of some of the light nuclei; beta-decay, particularly in the case of C^{14} where there is an order-of-magnitude effect in need of explanation; the molecular problem of quadrupole coupling particularly in relation to the measurement of the quadrupole moment of Li^7 in polar molecules. A.

539.152.1

6170. A binding energy calculation on He^4 with single-particle wave functions. P. G. WAKELY. Letter in *Phys. Rev.*, **90**, 724 (*May* 15, 1953).

A binding energy of 20·84 MeV is reached for He^4 by a variational calculation using a linear combination of three wave-functions each formed from single-particle oscillator wave functions and given explicitly, and using a symmetrical Pease–Feshbach potential fitted to the two- and three-body data. R. H. DALITZ

539.152.1

6171. Mathematical formulations of physical quantities for *j–j*-coupling nuclear shell model. S. YANAGAWA. *J. Phys. Soc. Japan*, **8**, 302–12 (*May–June*, 1953).

Fractional parentage coefficients defined by G. Racah for nuclear *j–j*-coupling wave functions $[(j)^2, j : (j)^3]$, $[(j)^3, j : (j)^4]$ and $[(j)^4, j : (j)^5]$ (maximum T only) for $j = 3/2$ and $j = 5/2$ are calculated by group theoretical methods. Using these coefficients, formulae are derived for the matrix elements of operators generally defined as $T_0^{(p)}(S^{(k)} \cdot L^{(k)})$ or $T_0^{(p)} S_0^{(0)} L_0^{(k)}$ in a nuclear configuration consisting of several closed shells and one unfilled shell, in terms of the basic two-body integrals. A.

539.152.1

6172. Spin orbit coupling and the mesonic Lamb shift. R. CHISHOLM AND B. TOUSCHEK. *Phys. Rev.*, **90**, 763–5 (*June* 1, 1953).

It is shown that the self-energy corrections for a nucleon moving in a scalar potential well lead to a strong spin–orbit coupling for pseudoscalar mesons. The effect is, however, opposite in sign to that required by the nuclear shell model. A.

539.152.1

6173. Spins and parities of excited states in even-even nuclei. I. M. J. GLAUBMAN. Letter in *Phys. Rev.*, **90**, 1000 (*June* 1, 1953).

Experimental results obtained so far suggest the rule that in even-even nuclei the low-lying even (odd) parity states have even (odd) spins. L. PINCHERLE

539.152.1

6174. Spins and parities of excited states in even-even nuclei. II. I. TALMI. Letter in *Phys. Rev.*, **90**, 1001 (*June* 1, 1953).

The rule enunciated in Pt I is explained theoretically by considering short range attractive central forces between the nucleons, in the same way that, on the basis of such a force, the order of levels in the l^n configuration (in *L–S* coupling) is predicted to be 0, 2, 4 . . . L. PINCHERLE

539.15[illegible]

6175. Odd-odd spins and *j–j* coupling. R. W. K[illegible] AND D. C. PEASLEE. Letter in *Phys. Rev.*, **90**, 1001 (*June* 1, 1953).

If *j–j* coupling were ideally followed, the pattern of odd-odd spins should be entirely symmetric with respect to holes and particles within the subshell; on the other hand, it is found that the spins tend to increase continuously throughout the filling of each subshell. L. PINCHERLE

539.152[illegible]

6176. Calculation of nuclear binding energies with single-particle oscillator wave functions. E. H[illegible] KRONHEIMER. Letter in *Phys. Rev.*, **90**, 1003–4 (*June* 1, 1953).

With a view to the study of interconfigurational mixing in light nuclei, formulae are given for the calculation of the necessary radial integrals, generalizing integrals given by Talmi [Abstr. 8996 (1952)]. R. H. DALITZ

539.152.

6177. Nuclear hyperfine structure of Mn^{++}. M. SACHS. *Phys. Rev.*, **90**, 1058–60 (*June* 15, 1953).

A theoretical calculation of the nuclear hyperfine splitting in Mn^{++} is made on the assumption that the ground state is composed of a mixture of the normal electronic configuration and a state created by moving an inner 3*s* electron to the 4*s* state. The ground-state wave function is then written as

$$\Psi = (1 - \alpha^2)^{\frac{1}{2}}\psi(3s^2 3d^5) + \alpha\psi(3s3d^5 4s)$$

The numerical calculation of α is limited primarily by the inaccuracy of the values of the 3*s* and 4*s* radial wave functions at the nucleus. The observed splitting is obtained for the value $\alpha^2 \simeq 4{\cdot}41 \times 10^{-4}$. The calculation was carried out by assuming a *jj* coupling model. A.

539.152.1

6178. On the shell structure of nuclei. I. G. SZAMOSI. Note in *Naturwissenschaften*, **40**, *No.* 3, 105–6 (1953) *In German.*

The single particle energy levels are plotted for a well produced by a constant spherical density distribution of sources of a Yukawa potential. A spin-orbit term $\sim -r^{-1}(dU/dr)$ is included. W. J. SWIATECKI

539.152.1 : 539.164

6179. A systematic of α-energies. S. SENGUPTA. *Z. Phys.*, **134**, *No.* 4, 413–18 (1953) *In German.*

A plot of α-energies increases smoothly with Z and decreases with N except for irregularities associated with $Z = 82$ (and 88, 92, 96). This is discussed in terms of the n and p binding energies and the shell model. W. J. SWIATECKI

539.152.2

6180. Determination of the magnetic moment of the As^{75} nucleus from the Zeeman effect of a nuclear quadrupole transition. H. KRÜGER AND U. MEYER-BERKHOUT. *Nachr. Akad. Wiss. Göttingen, Math.-phys. Kl IIa*, **1952**, *No.* 1, 1–6. *In German.*

Result: $\mu = 1{\cdot}44 \pm 0{\cdot}03$ n.m., in agreement with magnetic resonance experiments. L. PINCHERLE

539.152.2

6181. The nuclear magnetic moment of ^{57}Fe. R. S. RENAM. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 14–15 (*April*, 1953).

The paramagnetic resonance spectrum of iron with the isotope 57 enhanced to about 40% has been examined at 90°K using ferric potassium selenate alum. Comparison with results for unenhanced Fe enables an upper limit of 6 gauss to be set on the overall h.f.s. of Fe^{57}. Comparison with the spectrum of the isoelectronic Mn^{2+} ion gives an upper limit of 0·05 n.m. for the magnetic moment of Fe^{57}.

L. PINCHERLE

539.152.2

6182. Possible breakdown of isotopic spin and charge parity selection rules. D. H. WILKINSON. Letter in *Phys. Rev.*, **90**, 721 (*May* 15, 1953).

It must be anticipated that at high excitations the concepts of isotopic spin and of charge parity will cease to have much significance. This note indicates one probable and two possible cases in which they break down. L. PINCHERLE

539.152.2

6183. The purity of isotopic spin or charge parity states. G. A. JONES AND D. H. WILKINSON. Letter in *Phys. Rev.*, **90**, 722 (*May* 15, 1953).

See also preceding abstract. Observations on O^{16} and on B^{10} indicate 2 possible violations and 2 possible successes of the pure isotopic spin or charge parity selection rules and seem to accord with the expected effects of the Coulomb perturbation.

A. O. STANESBY

539.153

6184. The investigation of electron distribution in atoms by electron diffraction. L. S. BARTELL AND L. O. BROCKWAY. *Phys. Rev.*, **90**, 833–8 (*June* 1, 1953).

A procedure is developed for obtaining the radial distribution of electrons in free atoms from electron diffraction data which makes use of the similarity of the expressions characterizing the scattering of fast electrons and X-rays by atoms. Requirements are formulated pertaining to accuracy and angular range of data for such studies. A brief comparison is made of the method with the analogous X-ray method. Electron diffraction data for argon over the range of 0·9 to 44 in units of $(4\pi \sin \frac{1}{2}\theta)/\lambda$ are presented and found to give an experimental electron distribution resolving the *K*, *L* and *M* shells of argon in satisfactory agreement with the Hartree distribution. A.

539.153.4

6185. An equation for the numerical value of Sommerfeld's fine structure constant. J. FUCHS. Note in *Naturwissenschaften*, **39**, *No.* 22, 505 (1952) *In German.*

$$\pi^{3/2}[\pi^3/E^{1/2} - E^{1/2}/\pi^3] = 137{\cdot}0437;\ E = \sum_{n=0}^{\infty} e^{-n}$$

L. PINCHERLE

539.154.2

6186. Principal considerations in the periodic system of the elements. V–VII. R. LEPSIUS AND S. K. ASUNMAA. Note in *Naturwissenschaften*, **39**, *No.* 20, 477–8; *No.* 21, 490–1; *Erratum*, *No.* 23, 556 1952) *In German.*

For Pt III, see Abstr. 1173 (1952). Various plots of *N*, *Z* and *N–Z* with the object to showing a connection between the periods of atomic and nuclear structure. W. J. SWIATECKI

539.154.2

6187. An attempt to construct the periodic system of atomic nuclei. M. L. CHEPELEVETSKIĬ. *Zh. eksper. teor. Fiz.*, **23**, *No.* 3 (9) 327–35 (1952) *In Russian.*

An interpretation of periodicities of nuclear structure in terms of neutron periods with $N = \Sigma\frac{1}{3}n(n+1)(n+2)$ and proton periods with $Z =$ 0, 2, 4, 8, 12, 18, 24, 32 . . . W. J. SWIATECKI

539.155.2

6188. Isotope analyses of lead from minerals. H. F. EHRENBERG. *Z. Phys.*, **134**, *No.* 3, 317–33 (1953) *In German.*

The problem is first discussed, and published results are reviewed. The author used a 60° mass spectrometer, and discusses problems of resolution. He gives results for minerals from Katanga and the Uluguru Mountains (Africa), Twedestrand (Norway), the Erzgebirge and Mansfeld, and for lead ores from Meggen (Westphalia) and Schapbach (Black Forest).

F. R. HOLT

539.155.2

6189. Isotope separation with continuously operating separation tubes. E. DAVID. *Z. Phys.*, **134**, *No.* 3, 377–96 (1953) *In German.*

A general treatment of a thermal diffusion plant which has the correct cross-section at any concentration level, and therefore minimum power consumption and start-up time. For a particular gas, the design data for a given pressure, hot and cold wall temperatures and ratio of the radii of the walls can either be estimated from the formulae of Jones and Furry [Abstr. 1213 (1947)] or determined by experiments with a short tube. H. LONDON

539.155.2

6190. Thermal concentration of carbon isotopes using carbon monoxide gas. H. SAKATA, K. MATSUDA AND E. TAKEDA. *J. Phys. Soc. Japan*, **8**, 313–17 (*May–June*, 1953).

Using carbon monoxide as working gas, the concentration of C^{13} by thermal diffusion method was tried. The separation column was of the hot wire type, 5 m long. The separation factor of the column was measured under various pressures and temperatures. The maximum separation factor obtained at 53·7 cm Hg pressure and hot-wire temperature of 1050°K was 5·85. Under these conditions the relaxation time of the column whose both ends closed was about 4·7 hr. The comparison of the results with theory suggested the existence of parasitic remixing. The measured value of R_T of CO gas was 0·427. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08 : 621.387.46

6191. An improved wide-range radiation instrument. G. M. BURGWALD AND L. REIFFEL. *Nucleonics*, **11**, 46–8 (*March*, 1953).

The instrument employs a large NaI crystal and a

photomultiplier. The integrated output from the multiplier produces a d.c. potential across a resistor and this is compared to a reference potential. The error signal is amplified and drives a servo-motor, which in turn, operates a potentiometer controlling the h.v. supply to the multiplier, so that the average current output of the multiplier remains constant. There is an approximately logarithmic dependence between the drop in the high voltage and the light output from the NaI over a range of 10^7. The photomultiplier voltage thus gives an indication of the radiation level over a very wide range from 10^{-4}r per hr upwards. L. R. SHEPHERD

539.16.08 : 778.33

6192. Combined application of electronic reflection radiography and autoradiography to the study of radioactive minerals. J.-J. TRILLAT AND R. TERTIAN. *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 227–32 (*Sept.*, 1952) *In French.*

Gives more details of the methods and results already described in Abstr. 1859 (1953). J. THEWLIS

539.163 : 539.172

6193. Argon 38 in pitchblende minerals and nuclear processes in nature. W. H. FLEMING AND H. G. THODE. *Phys. Rev.*, **90**, 857–8 (*June* 1, 1953).

The isotopic constitution of argon extracted from four pitchblende samples of different age and uranium concentration has been determined. The A^{36}/A^{38} ratio was found to vary by over 300% with the greatest deviations from normal occurring in the ores with high uranium content. It is suggested that A^{38} has been produced in considerable quantities in these ores by nuclear reactions involving α-particles and/or the spontaneous fission neutrons. A.

539.163.1

6194. A new estimation of the half-value period of ThB (Pb^{212}). H. v. BUTTLAR. Note in *Naturwissenschaften*, **39**, *No.* 24, 575 (1952) *In German.*

The mean of 3 determinations using a liquid counter gave a $\frac{1}{2}$-life for ThB of $10{\cdot}67 \pm 0{\cdot}05$ hr.

A. O. STANESBY

539.163.1

6195. A method of measuring short beta-decay lifetimes. R. N. THORN AND R. W. WANIEK. *Rev. sci. Instrum.*, **24**, 391–3 (*May*, 1953).

A new method has been developed using the internal beam of the Harvard 95-inch F.M. cyclotron. Targets are irradiated at different proton energies, and the decaying activities are detected inside the tank by a scintillation crystal-Lucite pipe arrangement connected with a fast recording system. A.

539.163.2

6196. The decay scheme of RaC. A. H. WAPSTRA. *Physica*, **18**, 1247–9 (*Dec.*, 1952).

Preliminary β–γ coincidence measurements on RaC indicate that the highest energy β-transition is to the ground state of RaC′; the spin of Bi^{214} (RaC) is probably 2−. A. O. STANESBY

539.163.2

6197. Decay of ^{198}Au. L. SIMONS. *Physica*, **18**, 1250–2 (*Dec.*, 1952).

The β-spectrum of neutron-irradiated gold ($E_{max} = 0{\cdot}965$ MeV) was obtained using a Siegbahn double focusing magnetic spectrograph. The decay scheme of Au^{198} and energy levels of Hg^{198} are discussed. A. O. STANESBY

539.163

6198. 188Re^m, a new nuclear isomer of half-life 18·7 min. A. FLAMMERSFELD. Note in *Z. Naturforsch.*, **8a**, 217–18 (*Feb.–March*, 1953) *In German.*

The new activity was found by neutron irradiation of Re foils; the energy of the isomeric transition is ~60 keV. A. O. STANESB

539.163

6199. The decay of Rh^{104m} (4·3 min) and Rh^{1} (44 sec). W. C. JORDAN, J. M. CORK AND S. BURSON. *Phys. Rev.*, **90**, 862–4 (*June* 1, 1953).

The radiations of neutron-activated rhodium are studied with 180° constant field conversion electron spectrometers and a gamma-ray scintillation spectrometer. Internal conversion electrons are observed to be associated with the 4·3 min activity. These are interpreted as arising from two isomeric transitions of $51{\cdot}1 \pm 0{\cdot}2$ and $77{\cdot}2 \pm 0{\cdot}2$ keV in rhodium. By coincidence studies these two transitions are shown to be in cascade. The character of the radiations, as determined from the K/L ratios and lifetime considerations, appears to be $M1$ and $E3$, respectively. Additional gamma-rays of energy 550 ± 10 keV and ~1·2 MeV (weak) are observed with the scintillation spectrometer. The 550 keV transition is associated with both the 44 sec and the 4·3 min periods and is assumed to follow the beta-decay and hence be in Pd^{104}. A

539.163.2

6200. The disintegration of Sc^{47}. L. S. CHENG AND M. L. POOL. *Phys. Rev.*, **90**, 886–8 (*June* 1, 1953).

The radiations accompanying the disintegration of Sc^{47} have been investigated with a lens spectrometer and a scintillation spectrometer. The β-spectrum is complex and consists of two components of allowed shape with end-point energies, $0{\cdot}622 \pm 0{\cdot}005$ MeV and $0{\cdot}435 \pm 0{\cdot}008$ MeV. A γ-ray of energy $0{\cdot}185 \pm 0{\cdot}007$ MeV has been found. The 0·435 MeV β-ray is in coincidence with the 0·185 MeV γ-ray. A.

539.163.2

6201. Disintegration of 24-minute Ag^{106}. W. L. BENDEL, F. J. SHORE, H. N. BROWN AND R. A. BECKER. *Phys. Rev.*, **90**, 889–90 (*June* 1, 1953).

The 24 min isomer of Ag^{106} was produced by the (γ, n) reaction on metallic silver. A conversion line of a 512 keV γ-ray was found. The activity has a positron group of energy 1·96 MeV, a weak lower energy positron, and a possible weak negative β-group. An upper limit of 0·1% is placed on the positron component in the 8-day isomer of Ag^{106}. Previously unreported conversion lines of 66 min half-life were found in silver following bombardment of Pd by deuterons. A.

539.163.2

6202. Search for 1-MeV gamma from N^{16} decay. F. BOEHM, D. C. PEASLEE AND V. PEREZ-MENDEZ. Letter in *Phys. Rev.*, **90**, 1119 (*June* 15, 1953).

Scintillation counter observations failed to reveal any γ-rays in the region 0·5 to 6 MeV. It is deduced that the γ-ray transition between the 7·1 and 6·1 MeV levels of O^{16} has intensity $\leqslant 0{\cdot}05$ the intensity of the 6·1 MeV γ-ray. J. J. WILKINS

539.164 : 539.166

03. Angular correlations from liquid sources. V. POUND AND A. ABRAGAM. Letter in *Phys. Rev.*, , 993–4 (*June* 1, 1953).

Following a previous note referring to solid sources ee Abstr. 5011 (1953)], it is shown that discrepancies tween expected and observed angular correlations om liquid sources can result from the electric adrupole moment in the intermediate state of the ucleus. In liquids, however, the effect is smaller and mewhat of a different nature, due to the continuous ndom re-orientation of any electric field gradient.

L. PINCHERLE

539.165

204. The absorption coefficients of β-energy of adioactive isotopes in air-equivalent substances. K. SOMMERMEYER. Note in *Naturwissenschaften*, **39**, *No.* 22, 506–7 (1952) *In German.*

A point source was used, the counter being at arious distances from it. Results include: I^{131}, 19 nd S^{35}, 180 cm²/g. For P^{32} the ionization did not lecrease exponentially with distance. Results are ompared with others and with theory. F. R. HOLT

539.165

205. β-decay and the binding-energy of the atomic electrons; the primary spectrum of RaD. E. HUSTER. Note in *Naturwissenschaften*, **40**, *No.* 6, 197–8 (1953) *In German.*

The primary β-spectrum of RaD was obtained from pulse measurements of $RaD(CH_3)_4$ in a proportional counter, using those pulses corresponding to an energy $> 46{\cdot}5$ keV, the γ-ray energy of RaE. The spectrum has a max. at $\sim$8 keV, and $E_{max} = 24{\cdot}2 \pm 2{\cdot}5$ keV. The mechanism of the interaction is discussed, and it is shown that the electron and neutrino share the Coulomb energy liberated.

A. O. STANESBY

539.165

6206. The O^{14} β-decay and the Fermi interaction. M. E. ROSE. Letter in *Phys. Rev.*, **90**, 1123 (*June* 15, 1953).

Angular correlation measurements on O^{14} may provide information concerning the composition of the Fermi part of the β-interaction. It is shown how the recoil due to the 2·31 MeV γ-ray may be taken into account. L. PINCHERLE

539.165

6207. Search for double beta-decay in Sn^{124} and Zr^{96}. J. A. MCCARTHY. *Phys. Rev.*, **90**, 853–7 (*June* 1, 1953).

If double beta-decay takes place without the emission of neutrinos, the total kinetic energy of the two emitted electrons will be constant. The half-life would be of the order of 10^{16} years for 1·5 MeV available energy or 10^{14} years for 3·5 MeV available energy. Sn^{124} and Zr^{96} have been studied for evidence for such a process. A lower limit of $1{\cdot}5 \times 10^{17}$ years is set on the half-life for double beta-decay of Sn^{124}, which has $1{\cdot}5 \pm 0{\cdot}4$ MeV available energy. In the case of Zr^{96}, which has $3{\cdot}4 \pm 0{\cdot}3$ MeV available energy, the results indicate a lower limit of 2×10^{16} years for double beta-decay. The results also indicate the presence of a slight activity of $6 \pm 2 \times 10^{16}$ years half-life (if attributed to Zr^{96}) at $3{\cdot}8 \pm 0{\cdot}5$ MeV with an energy spectrum and coincidence nature compatible with the predictions for double beta-decay. Further experimentation is necessary to establish the existence and nature of this activity. A.

539.165.08

6208. Absolute beta-counting of gases containing P-32 using end-window Geiger–Müller tubes. F. D. ROSEN AND W. DAVIS, JR. *Rev. sci. Instrum.*, **24**, 349–54 (*May*, 1953).

Techniques for absolute β-counting of corrosive gases containing P-32 have been developed and applied to the determination of the vapour pressure of PF_5. Standard, end-window G.M. tubes were used; the PF_5 was contained in a separate gas cell having an aluminium window and body. Various factors required to convert counting rates to disintegration rates were determined; accuracy of the product of these was evaluated by comparison counting. Absolute activity values that were derived from gas counting data and an equation for the vapour pressure of PF_5 agreed with the activity measured from counting solid samples within 1·0%. The methods here developed are applicable to other phosphorus compounds as well as to other elements having gaseous derivatives and β-particle energies in excess of 0·5 MeV. A.

539.166

6209. Investigation of γ-rays by means of photoelectrons. L. YA. SHAVTVALOV. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 5 (11) 611–12 (1952) *In Russian.*

The spectrometer was of the modified semi-circular focusing type, described in Abstr. 6426 (1951). The target was of Pb, placed at $\sim$220° from the two counters, which were close together in order to reduce the effects of scattering in the first one. The source was $\sim$10 millicuries of Co^{60}. The 1·17 and 1·33 MeV γ-rays gave K and L electrons; half-width of K-lines $\sim$2%. J. C. E. JENNINGS

539.166

6210. Angular-distribution of γ-rays from stripping reactions. G. R. SATCHLER. Letter in *Phys. Rev.*, **90**, 722 (*May* 15, 1953).

Formulae are given relating the distributions calculated for a particular channel spin (of the capture process) to those calculated for particular cases of j–j or L–S coupling. Some explicit distributions of interest on the shell model hypothesis are also given.

J. J. WILKINS

539.166

6211. Inner bremsstrahlung and the magnetic moment of the neutrino. E. J. HELLUND. Letter in *Phys. Rev.*, **90**, 721 (*May* 15, 1953).

The intensity of the inner bremsstrahlung produced during the ejection of a neutrino of finite Pauli magnetic moment is $\propto g^2/\mu^2$, where g is the magnetic moment and μ the rest mass, of the neutrino. Experimental identification of the entire inner bremsstrahlung as due to β-radiation necessitates adoption of a smaller value for the upper limit of the neutrino moment than the 1/5000 Bohr magneton allowed by ionization measurements. A. O. STANESBY

539.166

6212. Rotational states in even-even nuclei. A. BOHR AND B. R. MOTTELSON. Letter in *Phys. Rev.*, **90**, 717–19 (*May* 15, 1953).

Recent data on the low-energy spectra of even-even nuclei support the interpretation of short-lived $E2$ isomers in terms of rotational states of the deformed nucleus. See also Abstr. 2668 (1953). A. O. STANESBY

539.166

6213. Gamma-gamma directional correlations in Co^{59}, Xe^{131}, and Hg^{198}. D. SCHIFF AND F. R. METZGER. *Phys. Rev.*, **90**, 849–52 (*June* 1, 1953).

The directional correlations of low-intensity gamma-gamma cascades have been measured using NaI scintillation counters in a coincidence arrangement of $1{\cdot}5\times10^{-8}$ sec resolving time. The correlation in the 3% intensity 191–1089 keV cascade in Co^{59} is compatible with a 3/2–5/2–7/2 spin assignment. The coincidences from the 284–80 keV cascade in Xe^{131} are isotropic within an error of 2%, supporting the assignment of spin $\frac{1}{2}$ to the 80 keV level. The large correlation observed in the ~1% intensity 680–411 keV cascade of Hg^{198} characterizes the spins of the levels involved as 2, 2, 0 and the 680 keV transition as a mixture of 60% $E2$ and 40% $M1$. A.

539.166.08

6214. A γ-ray detector with low efficiency for fast neutrons. G. R. BISHOP, G. PRESTON, J. M. WESTHEAD AND H. HALBAN. Note in *Rev. sci. Instrum.*, **24**, 395–6 (*May*, 1953).

The detector consists of two Geiger counters with aquadag-coated Perspex walls. The counters are separated only by a thin Styrafoil window which stops neutron-recoil protons of energy $\leqslant 3$ MeV, but is readily penetrated by Compton electrons. Observation of coincidences between the two counters has yielded an efficiency for 1·3 MeV γ-rays = 700 times the efficiency for 2·5 MeV neutrons. J. J. WILKINS

539.166.08 : 537.542

Two-crystal gamma-ray scintillation spectrometer. *See Abstr.* 6110

539.166.74

6215. Scattering of 1·3^3-MeV gamma-rays by an electric field. R. R. WILSON. Letter in *Phys. Rev.*, **90**, 720 (*May* 15, 1953).

A measurement of the elastic scattering of Co^{60} γ-rays by Pb is reported. At angles less than 90° the observed scattering was ~5 times lower than theoretical estimates of Thompson plus Rayleigh scattering. Destructive interference due to Delbruck scattering is inferred. J. J. WILKINS

539.166.75

6216. Transmission of Co^{60} gamma-rays through thick uranium. L. H. LANZL, L. S. SKAGGS, J. H. PINGEL AND J. E. ROSE. Note in *Rev. sci. Instrum.*, **24**, 394 (*May*, 1953).

Ionization chambers were used to measure the transmission from a central cylindrical source through thick cylindrical shells of uranium (of measured density $18{\cdot}88 \pm 0{\cdot}1$ gm/cm^3). Transmission factors of $1{\cdot}045 \pm 0{\cdot}005$ and $1{\cdot}05 \pm 0{\cdot}01$ cm^{-1} were obtained for shell thicknesses of 7·8 and 11·25 cm respectively. J. J. WILKINS

539.166.3

6217. Continuous gamma-radiation accompanying internal conversion in Ba^{137m}. H. B. BROWN AND R. STUMP. *Phys. Rev.*, **90**, 1061–3 (*June* 15, 1953).

A weak continuous gamma-radiation accompanying internal conversion has been observed from the decay of the isomeric state of Ba^{137}. The probability of this emission is $(1{\cdot}17 \pm 0{\cdot}27)\times10^{-3}$ photons in the energy range 50 to 100 keV per conversion electron and $(3{\cdot}4 \pm 0{\cdot}8)\times10^{-3}$ photons in the energy range 50 to 200 keV per conversion electron. The angular distribution of the continuous radiation in the energy range 50 to 200 keV has been measured at angles from 90° to 160° with the electron direction. There appears to be no deviation from isotropy. A.

NUCLEAR REACTIONS 539.17

539.17

6218. Resonance scattering in indium. L. B. BORST. *Phys. Rev.*, **90**, 859–62 (*June* 1, 1953).

Resonance scattering from the 1·458-eV level of indium has been studied by a bright-line technique. Resonance-scattering cross-section of 1600 barns corresponds to a scattering level width of 0·0052 eV and a Γ_n/Γ of 4·5%. A.

539.17 : 539.11

6219. Effects of nuclear radiations on the mechanical properties of solids. G. J. DIENES. *J. appl. Phys.*, **24**, 666–74 (*June*, 1953).

The general nature of radiation effects in solids is reviewed briefly. Current theoretical understanding of the mechanical properties of solids is critically evaluated. The effect of nuclear radiation on the mechanical properties is discussed in detail. It is shown that the changes in the mechanical properties of crystalline substances (mostly metals) can be quite satisfactorily interpreted on the basis of the production of interstitial atoms and vacant lattice sites by fast particle irradiation. Isolated vacancies and interstitials may not be able to account for all the observations, and attention is called to the possible need of postulating the existence of aggregates of these lattice defects. In molecular solids (mostly high polymers) nuclear radiations bring about changes in the substance which are best described as chemical ones. Ions and free radicals are formed leading to subsequent chemical reactions thereby altering the properties of the substance. Drastic changes in the mechanical properties of high polymers are observed. Correlation with structural changes has hardly been started. Experiments are suggested which, in the writer's opinion, should give further insight into the fundamental processes involved. A.

539.17 : 539.4.016.3

Annealing of bombardment damage in solids. *See Abstr.* 6272

539.172

6220. Maximum energy of the neutrons from capture of negative μ-mesons by iron nuclei. L. NIKLAS AND K. H. LAUTERJUNG. *Z. Naturforsch.*, **8a**, 214–16 (*Feb.–March*, 1953) *In German.*

The μ component of cosmic rays was filtered

rough 165 g cm^{-2} air equivalent of Pb and neutrons eased by the flux of 2·3 μ^- mesons per minute pped in an Fe block were detected by recoil otons from surrounding paraffin by a system of unters. Comparison with the calculated dependence the yield on the thickness of paraffin and Al sorption measurements on the protons indicate utrons with 40–50 MeV. W. J. SWIATECKI

539.172

221. The multiplicity of neutrons from the interaction of μ^- mesons at rest in Pb, Bi, Sn and Al. L. WIDGOFF. *Phys. Rev.*, **90**, 891–9 (*June* 1, 1953).

The average multiplicity $\langle\nu\rangle$ of neutrons emitted om a nucleus which has absorbed a μ^- meson has en determined for several materials: $\langle\nu\rangle = 2{\cdot}14 \pm$ ·13 for Pb, 2·32 ± 0·17 for Bi, 1·54 ± 0·12 for n, 0·95 ± 0·17 for Al. From $\langle\nu\rangle$, by using compound nucleus theory, the average excitation given ne nucleus was found to be about 20 MeV for all ne nuclei studied. The μ^- meson interactions were assified according to the number n of neutrons bserved per event and from the observed distributons in n some properties of the functions $I(\nu)$, which ive the probability of events in which exactly ν eutrons are emitted, have been determined. The esults indicate higher values of neutron multiplicity nd excitation energy than have been calculated by iomno and Wheeler, and Rosenbluth, but are onsistent with the assumption that a large part of ne rest energy of the μ^- meson is carried out of the ucleus by a light neutral particle. A.

539.172

222. The sign of the phase shifts in meson–nucleon cattering. H. A. BETHE. Letter in *Phys. Rev.*, **90**, 94–5 (*June* 1, 1953).

Points out and discusses the experimental evidence n the scattering of mesons by carbon nuclei which upports the assignment of a positive phase shift to he $P_{3/2,3/2}$ wave in meson–nucleon scattering. R. H. DALITZ

539.172

223. Evidence for the emission of a neutrino ollowing the nuclear capture of a negative μ-meson. W. F. FRY. Letter in *Phys. Rev.*, **90**, 999–1000 (*June* 1, 1953).

Four two-pronged stars, produced in nuclear emulsion by μ^- meson capture in O^{16} and N^{14}, are discussed. Study of the conservation of energy and momentum in each star strongly indicates emission of a neutrino, with energy 70–84 MeV. J. J. WILKINS

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 6121, 6127–8

539.172.11

224. Elastic scattering of alpha-particles by oxygen. J. R. CAMERON. *Phys. Rev.*, **90**, 839–44 (*June* 1, 1953).

The differential cross-sections for elastic scattering of alpha-particles by O^{16} were measured in a gas-scattering chamber using alpha-particles accelerated n an electrostatic generator over the energy region rom 0·94 to 4·0 MeV. Cross-sections were measured at θ(c.m.) = 168·0°; 140·1°; 124·6°; and 90·0°. Because both particles have zero spin the partial wave analysis is exceptionally simple and fixes unambiguously the angular momentum and parity of each level. The resonances were analysed using the Wigner–Eisenbud one-level approximation to determine the width and resonant energy of each resonance. Five scattering anomalies were observed which correspond to excited states of Ne^{20} with the following energies, angular momenta, and parities: 6·738 MeV, $J = 0^+$; 7·182 MeV, $J = 3^-$; 7·218 MeV, $J = 0^+$; 7·450 MeV, $J = 2^+$; and 7·854 MeV, $J = 2^+$. The uncertainty in these energies is about 10 keV, most of which is due to the uncertainty of the energy loss in the gas. None of the levels have reduced widths greater than 2% of the single particle width. A.

539.172.11

6225. Elastic scattering of alpha-particles by carbon. R. W. HILL. *Phys. Rev.*, **90**, 845–8 (*June* 1, 1953).

The $C^{12}(\alpha,\alpha)C^{12}$ differential scattering cross-sections were measured in a gas scattering chamber at θ(c.m.)= 171·0°, 147·2°, 125·5° and 92·0° with alpha-particles accelerated in the Wisconsin electrostatic generator. Cross-sections were measured at alpha-particle energies from 0·5 to 4·0 MeV. For zero spin nuclei bombarded by zero spin particles, each partial wave contributing to the cross-section vanishes at some angle except that for $l = 0$. The P wave vanishes at 90·0°, the D wave at 125·3°, the F wave at 140·8°, and the G wave at 149·5°. Thus, by observing the cross-sections near these angles it was possible to determine the J values and parities of the levels. Analysing the data by means of the Wigner–Eisenbud one-level approximation to determine the widths and resonant energies confirmed the qualitative characterization of the levels. With the O^{16} ground state as the energy zero, the J values, parities and excitation energies of the two levels observed are $J = 1^-$ at 9·58 MeV and $J = 2^+$ at 9·835 MeV. The uncertainty in these energies is about 10 keV. The reduced width of the P resonance is approximately 100% of the single-particle width, and that of the D resonance is 0·15%. A.

539.172.13

6226. The reactions $T(p,n)He^3$ and $T(p,\gamma)He^4$. H. B. WILLARD, J. K. BAIR AND J. D. KINGTON. *Phys. Rev.*, **90**, 865–7 (*June* 1, 1953).

A differential cross-section curve for neutrons emitted at 0° from the reaction $T(p,n)He^3$ has been measured from threshold to 5·09 MeV. A broad maximum appears at 3 MeV. Angular distributions were taken at approximately 0·4 MeV intervals and are nonsymmetrical about the 90° plane in the centre-of-mass system. An 80° relative yield curve of γ-rays from the $T(p,\gamma)He^4$ reaction was obtained from 1 to 5 MeV. It increases up to 3 MeV proton energy and then levels off. A.

539.172.3

6227. An excitation curve for photomesons from beryllium. D. LUCKEY. Letter in *Phys. Rev.*, **90**, 711 (*May* 15, 1953).

Yields of 54 MeV π^- and π^+ mesons at 90° have been measured for synchrotron energies up to 310 MeV. Comparison with yields from carbon and hydrogen suggests that the "extra neutron" of Be^9 acts as if it were free. J. J. WILKINS

539.172.3

6228. Photoneutron reaction in Ca^{40}. R. BRAAMS AND C. L. SMITH. Letter in *Phys. Rev.*, **90**, 995 (*June* 1, 1953).

Irradiation of calcium with 30 MeV X-rays induced an activity of $4{\cdot}7\times10^3$ disintegrations/g/R, with half-life $1{\cdot}00 \pm 0{\cdot}05$ sec and maximum β^+ energy $6{\cdot}7 \pm 0{\cdot}5$ MeV. J. J. WILKINS

539.172.3

6229. The azimuthal distribution of photoelectrons produced by 0·5 MeV polarized photons. F. L. HEREFORD AND J. P. KEUPER. *Phys. Rev.*, **90**, 1043–6 (*June* 15, 1953).

The azimuth angular distribution of photoelectrons ejected from lead by linearly polarized 0·51 MeV photons has been studied. The known correlation between polarization states of annihilation quanta was employed in preparation of the incident beam of polarized photons. Results indicate that for emission from the *K* shell, the most probable direction is in the plane containing the momentum and polarization vectors of the incident photon. The asymmetry in the distribution thereby produced is slightly greater than that expected from the relativistically computed differential cross-section. A.

539.172.3

6230. The photodisintegration cross section of beryllium at 2·185 MeV. B. HAMERMESH AND C. KIMBALL. *Phys. Rev.*, **90**, 1063–5 (*June* 15, 1953).

The cross-section for the photodisintegration of Be^9 at 2·185 MeV has been measured using γ-rays which follow the β-decay of Pr^{144}. A value of $3{\cdot}9\times10^{-28}$ cm^2 was found, in reasonably good agreement with the valence neutron model. This value is lower than the values at 1·81 MeV and 2·50 MeV, in agreement with the theoretical prediction that a minimum value of the cross-section should be found near 2·2 MeV. A.

539.172.4

6231. The angular distribution of $Li^6(n, \alpha)H^3$ for neutrons of 200, 270, 400, and 600 keV. L. E. DARLINGTON, J. HAUGSNES, H. M. MANN AND J. H. ROBERTS. *Phys. Rev.*, **90**, 1049–53 (*June* 15, 1953).

The angular distribution of $Li^6(n, \alpha)H^3$ has been measured for neutron energies of 200, 270, 400 and 600 keV by determining the distribution of triton tracks from this reaction in Ilford *C*2 plates loaded with enriched Li^6. The results fit a series of the type $A + B\cos\phi_0 + C\cos^2\phi_0$, where ϕ_0 is the neutron-triton angle in the centre-of-mass system. This indicates that the *s* and *p* components of the incident neutron wave predominate in the interaction. A.

539.172.4

6232. The neutron activation of Ca^{46}. L. G. COOK AND K. D. SHAFER. Letter in *Phys. Rev.*, **90**, 1121 (*June* 15, 1953).

Ca^{47} has not been reported as observed directly in neutron-irradiated Ca. It was observed indirectly by following the decrease in yield of its daughter product Sc^{47} on successive separations; the $\frac{1}{2}$-life obtained was $4{\cdot}8 \pm 0{\cdot}5$ days, and the thermal neutron activation cross-section $Ca^{46} \rightarrow Ca^{47}$ $0{\cdot}25 \pm 0{\cdot}1$ barn. A. O. STANESBY

539.17?

6233. Production of fissionable isotopes in a therm reactor. L. B. ROBINSON. *Phys. Rev.*, **90**, 1054 (*June* 15, 1953).

Differential equations representing isotopic pr duction and decay schemes are discussed. T Bateman equations are suitable for the description naturally occurring processes. Van Wye and Becker have given equations which describe process occurring in a thermal reactor, if feedback is neglecte Their equations are modified so that feedback mig be included. Examples are given which show the ro and the origin of feedback. In a conversion reactc the phenomenon of resonance capture and th operation of the reactor at criticality are responsibl for feedback. An example is also given of th appearance of feedback resulting from the productic of Pu^{239} from neutron capture by U^{235} and neutro capture by, and β-decay of Pu^{239} products. Th latter example is of more use conceptually tha practically. A method of accounting for fuel replace ments is also discussed. Some special systems ma be treated as general dynamical systems; a method i shown which will determine whether they are con servative or nonconservative. Such information is o both practical and theoretical importance. A

539.172.4 : 518.

Nomograms used in analysis of data in the reaction $Li^6(n, \alpha)H^3$. *See Abstr.* 5829

539.172.4 : 621.039 : 621.317.79

6234. A pile period or reactivity meter. T. E BURNUP AND J. H. BOWEN. *Electronic Engng*, **25** 190–1 (*May*, 1953).

The theory relating to pile reactivity is given and shown to lead to the need for an instrument to cover (*a*) the primary measuring element for determining the neutron density at a point, (*b*) an instrument to measure the time interval, (*c*) a device to measure the neutron density ratios. Generally an ion chamber is used for (*a*) and for (*b*) various devices are possible and discussed. (*c*) requires a comparison of voltages; one using a voltage reference tube is described. Tests have shown such an instrument to read up to 100 sec within 0·01 sec. E. H. W. BANNER (R)

ATOM AND MOLECULE BEAMS
MESONS . NEUTRONS 539.18

539.18

6235. The total cross sections of 37-MeV pions in hydrogen. C. E. ANGELL AND J. P. PERRY. Letter in *Phys. Rev.*, **90**, 724 (*May* 15, 1953).

A refinement of the method of Abstr. 8479 (1952) gives $16{\cdot}0 \pm 1{\cdot}0$ and $17{\cdot}3 \pm 1{\cdot}4$ mb for π^+ and π^- respectively. W. J. SWIATECKI

539.18

6236. Charge-exchange scattering of 34-MeV π-mesons in hydrogen and deuterium. A. ROBERTS AND J. TINLOT. *Phys. Rev.*, **90**, 951–9 (*June* 1, 1953).

Both single photons and two-photon coincidences were detected. The results are relatively independent of the assumed angular distribution of the π-mesons. A value of $5{\cdot}0 \pm 1{\cdot}5$ millibarns was obtained for the

al charge-exchange cross-section of π^--mesons in drogen. The expected null result was obtained for -mesons in hydrogen. In deuterium, values of out one-third the hydrogen cross-section were tained for both signs of meson. The photons served from carbon and oxygen do not appear to mainly from π^0-decay, and the cross-section for production in C and O is less than 5 mb for both gns of meson. The two-photon coincidences yield rough value of 0·8 mb/sterad for the differential arge-exchange cross-section for π^- on hydrogen 90°. The accuracy is sufficient to rule out the ossibility of a very deep minimum at 90°, e.g. a $\sin^2\theta$ angular distribution. A.

539.18

6237. The absorption of slow π^- mesons by He^4 uclei. A. G. PETSCHEK. *Phys. Rev.*, **90**, 959–67 *une* 1, 1953).

On the assumption of central charge-independent vo particle nuclear forces, the wave function $E + K)^{-2}(bE + K)^{-2}$ with E the binding energy, K ie kinetic energy, and $b = 5·3$ is found to be a better ave function, in the sense of a variational principle, or the He^4 nucleus than the optimum Gaussian. With this wave function, the ratios of the numbers of rotons to deuterons to tritons in final states resulting om the absorption of π^--mesons from K shells of esic helium atoms are found to be 1 : 1·3 : 0·7. or reasonable values of the $PS(PV)$ coupling constant, 20% of the absorptions take place directly from he $2p$ level. The number of high-energy γ-rays is ss than 1% of the number of nonradiative absorptions. Charge-exchange absorption is energetically orbidden. A.

539.18

6238. Inner bremsstrahlung in μ-meson decay. A. LENARD. *Phys. Rev.*, **90**, 968–73 (*June* 1, 1953).

The transition probability for the decay of a μ-meson resulting in the simultaneous ejection of an electron and a photon is computed. Its dependence on the energies of the two emitted particles and on he angle between their direction of emission is given or the general case of an arbitrary mixture of three asic Fermi-type interactions for the μ-decay process. A.

539.18

6239. The production of heavy mesons. L. S. KOTHARI. *Phys. Rev.*, **90**, 1087–9 (*June* 15, 1953).

Using Fermi's theory of multiple production, the production of heavy mesons in a nucleon–nucleon collision (with primary energy $< 20\,Mc^2$) is studied. One obtains the result that heavy mesons should be produced singly about 10 times more frequently than in pairs. Creation of mesons in a meson-nucleon collision is also considered, and it is found that mesons of energy $E < Mc^2$ would, most likely, pass through nuclear matter without further creation of mesons, while for $E > 2\,Mc^2$ the probability of multiplication is large. In a qualitative way, the results deduced seem to agree rather well with experiments. A.

539.185

6240. Angular distributions of elastically scattered 1-MeV [±100 keV] neutrons. M. WALT AND H. H. BARSCHALL. Letter in *Phys. Rev.*, **90**, 714 (*May* 15, 1953).

These were measured for Fe, Ni, Cu, Zn, Ag, Cd, In, Sn, Hf, Pb, Bi. They show a systematic dependence on A. The total cross-sections and estimates of inelastic cross-section are given [see also Abstr. 6074 (1952)]. W. J. SWIATECKI

539.185

6241. An eighty channel velocity selector for neutrons. E. GATTI. *Rev. sci. Instrum.*, **24**, 345–8 (*May*, 1953).

Sequential switching of the eighty channels of the instrument (each 0·5, 5 or 50 μsec in width) is obtained by photomultipliers coupled to a cathode-ray tube screen. A.

539.185

6242. Low voltage 14-MeV neutron source. S. G. FORBES, E. R. GRAVES AND R. N. LITTLE. *Rev. sci. Instrum.*, **24**, 424–7 (*June*, 1953).

A compact accelerator has been built which utilizes tritium targets bombarded by deuterons. A neutron source strength of 10^8 neutrons per second was achieved. It was possible by using a relatively low accelerating voltage of about 100 kilovolts to arrange the whole assembly so that it could easily be transported from one location to another. A.

539.185

6243. The scattering of slow neutrons by O_2 molecules. O. HALPERN AND G. L. APPLETON. *Phys. Rev.*, **90**, 869–79 (*June* 1, 1953).

The scattering of slow neutrons by O_2 is due to nuclear interaction as well as magnetic forces arising from two magnetically active electrons. The molecular (nuclear) scattering is subdivided into elastic (coherent and incoherent) transitions and inelastic (mostly hyperelastic) transitions. The magnetic scattering is purely incoherent and essentially elastic. Numerical values are obtained for the integral cross-sections of these various scattering processes in dependence upon the wavelength. The case of very long neutron wavelength is of greatest physical interest, since only then can a sizable magnetic effect be expected. The analysis requires careful consideration of the thermal motion of the O_2 molecules, which sometimes influences the order of magnitude of the result. More accurate experiments can be expected to lead to an independent measurement of the distribution of the magnetically active shell of valence electrons. A.

STRUCTURE OF SOLIDS 539.2

539.211

6244. Theory of reversible and irreversible cracks in solids. YA. I. FRENKEL'. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1857–66 (1952) *In Russian.*

The author presents a critical analysis of Griffith's theory of crack formation (1921) based on critical overstressing and "catastrophic" developments of cracks leading to complete fracture, and shows that, notwithstanding strong *a priori* reasons for rejecting the basic assumptions of this theory, even their acceptance leads soon to irresolvable contradictions above all with experimental facts, but also of a

formal and physical nature. The author's own theory is then built up step by step from the comparatively simple case of a longitudinal cleavage of a crystal plate "*more geometrico*," but considering demonstrable physical configurations of actual cracks (particularly the edge formation which is patently misconceived by Griffith) and supplemented by well established relations between surface energy, surface tension and strength of the material. A relation is obtained between length of the crack and tensile stress in the case of the cleavable plate which takes the form of a 3rd-order differential equation. It is then shown that the same result can be derived from the maximum condition of the energy of the system considered, this also permitting of determining the effective depth of the crack. The condition of reversibility or otherwise of the process, thus the decision whether catastrophic degeneration of the crack or contraction and healing will follow the attainment of the critical length, follows naturally and easily from the relations derived. B. F. KRAUS

539.215 : 548.5

6245. On the theory of isothermal growth of crystalline grains in metallic alloys. M. P. Levitskiĭ. *Zh. tekh. Fiz.*, **22**, *No.* 3, 480–6 (1952) *In Russian.*

Thermodynamic treatment of grain growth in the solid state. Suggests extension to long time periods of archeological interest. W. BARDSLEY

539.217

6246. Evaluation of diffusion coefficients for single-phase and multi-phase diffusion in solid alloys. T. Heumann. *Z. phys. Chem.*, **201**, *No.* 3–4, 168–89 (*Dec.*, 1952) *In German.*

It is demonstrated that the coefficient of the single-phase diffusion can be determined from the first law of Fick without postulating conditions the fulfilment of which is required when one uses the second law of Fick. Methods are also described for the evaluation of the diffusion coefficients for intermetallic phases merely from the width of growth without using the c–x curves. Similar considerations are applied to cases of diffusion through a plurality of phases, as illustrated by the example of the Ag–Zn system. F. LACHMAN

539.217

6247. Flow of oxide layer during oxidation of copper. W. J. Moore. Letter in *J. chem. Phys.*, **21**, 1117 (*June*, 1953).

539.217

6248. Relation between the partial and the collective diffusion coefficients in metallic mixed crystals. T. Heumann. Note in *Naturwissenschaften*, **40**, *No.* 5, 164 (1953) *In German.*

A new relation between these diffusion coefficients has been derived and in this note is compared with experimental information on Ag–Au, Zn–Cu, Zn–Ag, Cu–Ni systems. The agreement is good.

P. T. LANDSBERG

539.232 : 548.74 : 548.538

On the structure of thin zinc-oxide layers on zinc single-crystal surfaces. *See Abstr.* 6307

539

6249. An investigation of boron carbide. F. Glaser, D. Moskowitz and B. Post. *J. appl. Phy* **24**, 731–3 (*June*, 1953).

Mixtures of boron and carbon were heated approximately 2000°C; the reaction products ha been studied by X-ray diffraction and by density a electrical measurements. The existence of a wi range of homogeneity of "boron carbide" has be established. No evidence of compound formati corresponding to B_4C could be detected. Similariti between the structures of boron and "boron carbide indicate that the latter may best be described solutions of varying amounts of carbon in a slight distorted boron lattice.

539.26 : 536.

6250. X-ray scattering from liquid helium. Reekie, T. S. Hutchison and C. F. A. Beaumon *Proc. Phys. Soc.* [*London*] *A*, **66**, 409–10 (*Apr* 1953).

Using a circular camera, which covers angles u to 2θ values of 155°, the structure is investigate between 4°·2 and 1°·36K. Both helium I an helium II give a "liquid-ring" type diffraction ($2\theta = 28°{\cdot}5$), and there is no outstanding differenc between them. A subsidiary maximum appears $2\theta = 55°$ at all temperatures. C. TURNE

539.26 : 539.4.016.

6251. The small angle scattering of X-rays fro cold-worked solids. D. L. Dexter. *Phys. Rev.*, 9 1007–12 (*June* 15, 1953).

The small angle scattering of X-rays or therma neutrons from cold-worked crystals is calculated o the basis of two models, according to which th scattering arises predominantly from the densit variation associated either with small cavities or wit edge-type dislocations. The elastic distortions sur rounding the cavities are unimportant, so that the scattering from cavities in a uniform medium o density n is the same, to a good approximation, as that from particles (in vacuum) of density n of the same size as the cavities. Thus the usual formulae of small angle scattering obtain, the scattered intensity has the familiar Gaussian-like dependence on scatter ing angle, and earlier results on multiple scattering may be applied. Around edge-type dislocations, on the other hand, the density variation is proportional to $\sin\xi/r$, where ξ is the angle measured from the slip direction in the plane perpendicular to the dislocation line and r is the distance from the dislocation line. This angular variation results in a complete modifica tion of the usual formulae, and, in fact, all of the terms ordinarily present disappear for this case, and conversely. The scattering shows a parabolic increase from zero at small angles, a maximum, and finally a monotonic decrease with increasing scattering angle. There is a large degree of anisotropy in the scattering, depending on the direction of the incident beam relative to the slip and dislocation axes. Multiple scattering from an array of dislocations in even a thick specimen is shown to be negligible. The theory is compared with Blin and Guinier's preliminary experimental results, and it is concluded that dislocations are incapable of explaining their data,

though it is expected that under suitable conditions e measurement of the scattering from dislocations ould be experimentally feasible. A.

539.27

252. Electron microscope observations of the urface of stretched pure aluminium. I. H. WILSDORF ND D. KUHLMANN-WILSDORF. *Z. angew. Phys.*, **4,** *Vo.* 10, 361–70 (1952) *In German.*

The surface of pure Al was coated by Si monoxide apour and was examined in the electron microscope efore and after extension between 0·5 and 64%. A ery fine step structure was observed covering the hole surface outside the flow bands. The develop- ent of the flow bands is illustrated by electron icrographs and the relation between the density of hese bands and the mechanical properties or treat- ent of the specimens is given. H. J. H. STARKS

539.27

253. Electron microscope observations of the urface of stretched pure aluminium. II. H. WILSDORF ND D. KUHLMANN-WILSDORF. *Z. angew. Phys.*, **4,** *Vo.* 11, 409–18 (1952) *In German.*

Electron micrographs are given to illustrate some f the surface disturbances which occur during the lastic deformation of pure Al. These include ension and compression slip bands, cross slip and urved slip bands. The relations between some of hese are discussed. H. J. H. STARKS

539.27

6254. Electron microscope observations of the surface of stretched pure aluminium. III. H. WILSDORF AND D. KUHLMANN-WILSDORF. *Z. angew. Phys.*, **4,** *No.* 11, 418–24 (1952) *In German.*

Methods of determining the geometrical relation- ships in flow bands are described and the results obtained from electron microscope observations are listed. This part includes a detailed summary of the 3 parts of the paper. H. J. H. STARKS

539.27

6255. An electronographic investigation of hydroxide films on the metals Mg, Al, Fe and Cu. N. A. SHISHAKOV. *Zh. fiz. Khim.*, **26,** *No.* 1, 106–11 (1952) *In Russian.*

Electron diffraction work indicates the existence of a new form of AlOOH having a hexagonal brucite-type structure. A mechanism is suggested for its transformation into the stable orthorhombic γ-AlOOH. New hexagonal forms of $Cu(OH)_2$ and FeOOH were found on surfaces treated with alkaline solutions of oxidizers. A further new hydroxide of Fe seems to be produced on the interaction of Fe condensed *in vacuo* and low-pressure water vapour. Powder photograph data are given. A. L. MACKAY

539.27

6256. Titanium replica for electron microscopy. S. YAMAGUCHI AND T. NAKAYAMA. Letter in *J. appl. Phys.*, **24,** 658 (*May*, 1953).

Titanium films evaporated on to glass surfaces can be floated off in water. When thermally oxidized, the films show no granular coarsening. R. S. PEASE

539.27

6257. A method of preparing replicas for electron microscopic examinations. W. S. SMITH AND W. G. KIRCHGESSNER. Letter in *J. appl. Phys.*, **24,** 662 (*May*, 1953).

Shadowed silica replicas were made by evaporating silica on to shadowed formvar negative replicas, and subsequently dissolving away the formvar.

R. S. PEASE

539.27

6258. A note on "Metallic shadow-casting using a nozzle system." S. YAMAGUCHI. Letter in *J. appl. Phys.*, **24,** 815 (*June*, 1953).

See Abstr. 9087 (1952). It is pointed out that metals evaporated or sublimed with difficulty from a tungsten basket will probably be contaminated with tungsten, and the application of Graham's law to diffusion through a nozzle may even lead to preponderance of tungsten.

539.27

6259. Electron microscope photography of rough surfaces. H. PFISTERER. Note in *Naturwissenschaften*, **40,** *No.* 3, 106 (1953) *In German.*

A replica method based on the use of Triafol is described for the examination of rough, granular or porous materials. A silicon oxide layer is deposited on the Triafol replica and the base removed by a solvent. The use of the method is illustrated by photographs of the surface structure of porcelain, sintered ceramic and calcined anthracite.

H. J. H. STARKS

539.27 : 538.245

6260. Electron microscopical investigations of ferromagnetic domains. A. ECKARDT AND B. ELSCHNER. Note in *Naturwissenschaften*, **39,** *No.* 24, 566–7 (1952) *In German.*

Describes experiments on large grained Fe–Si specimens. The colloidal Fe_3O_4 is dried, the particles removed together with the replica and dissolved off the replica surface prior to observation. A typical photograph is given showing 90° domain walls on a surface almost parallel to the (100) plane.

E. P. WOHLFARTH

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

6261. On the theory of deformation of rubber. G. M. BARTENEV. *Zh. tekh. Fiz.*, **22,** *No.* 7, 1154–65 (1952) *In Russian.*

The two components of rubber deformation: (1) the Hooke's component, which in the normal state forms about 0·05% of the total deformation, but has to be taken into account at low temperatures, large deformations, etc., and (2) the highly elastic component, previously incorrectly computed by the author [Abstr. 2087 (1951)], are derived theoretically and determined experimentally. From the comparison of data, conclusions are drawn concerning the structure of rubber and the assumptions and results of previous investigators. A. GELBTUCH

539.31 : 536.21

Determination of thermo-elastic stresses in a cylindrical tube. *See Abstr.* 5994

539.31 : 536.7

6262. Statistical thermodynamics of rubber elasticity. H. M. James and E. Guth. *J. chem. Phys.*, **21**, 1039–49 (*June*, 1953).

The basic concepts and procedures underlying the theory of rubber elasticity are analysed. The arguments advanced by Wall and Flory against the network theory of the authors are shown to be without foundation. The alternative theory which they advocate, and which is rather widely used, is criticized on two grounds: (*a*) it assumes a distribution of chain extensions that does not vary with network extension in the way the actual distribution functions can be shown to vary, and (*b*) the methods used to compute the numbers of network configurations from the distributions of chain extensions are invalid, except in the most trivial cases. The concept of "interval dilation entropy" is discussed, and is shown to lack any physical basis. It is concluded that all the methods of calculation that lead to logarithmic terms in the network configuration entropy are incorrect, and that these terms, which affect the theory of swelling, should be discarded. A.

539.32

6263. Mechanical investigations of elastomers in a wide range of frequencies. W. Philippoff. *J. appl. Phys.*, **24**, 685–9 (*June*, 1953).

A method has been found for measuring the shear moduli and losses of elastomers in a range of frequencies of about 1 to 10^6, from 10 c/s down. This method provides for large cyclic shear stresses and deformations without employing resonance methods. Only one sample is needed for a complete study, the frequency of stress being the only variable. The method gives results that fit the "box-distribution function" developed by Kuhn and Kuenzle. Results for a series of elastomers show that such investigations are important in ascertaining the mechanical properties of elastomers in practice. A.

539.32 : 539.374

6264. The relationship between the Poisson coefficient and the plastic properties of substance. I. I. Cherkasov. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1834–7 (1952) *In Russian.*

A comparison of the experimental data on the determination of the Poisson coefficient with the data on hardness and the relative decrease in the limit of the tensile strength of various substances shows that all the indices of ductility increase with an increase in the Poisson coefficient. For brittle and elastic materials such as glass or quenched steel the Poisson coefficient approaches the theoretical value of $\mu = 0{\cdot}25$. For soft and ductile materials such as lead or plasticine the Poisson coefficient approaches the value of $\mu = 0{\cdot}50$. A definite relationship between the Poisson coefficient and the characteristics of the ductility of substances is observed. The author develops approximate formulae for the ductility constant which may be expressed in terms of the plasticity β, which in turn is dependent on the Poisson coefficient. He shows by a number of concrete examples that the formulae are substantiated [illegible] experimental data. The best agreement is obtain[ed] for metals with regular crystalline lattices, and [illegible] general for isotropic substances. E. RABK[IN]

539.32 : 541.[illegible]

6265. Dynamical study on the secondary anomalou[s] absorption region of polymethyl methacrylate. Iwayanagi and T. Hideshima. *J. Phys. Soc. Japa[n]* **8**, 368–71 (*May–June*, 1953).

Secondary absorption region of polymethyl meth[acrylate] acrylate was studied dynamically. In addition to th[e] absorption region, which corresponds to so-calle[d] second-order transition or softening temperature, [a] secondary absorption region was found at lowe[r] temperature, its peak being lower and broader. B[y] means of bending and torsional vibrations, fre[quencies] quencies for the maximum absorption were measure[d] at several temperatures. The activation energy c[alculated] 29 kcal/mol was obtained. The results of the experi[ment] ment were compared with those obtained electricall[y] by Mead and Fuoss. A.

539.32 : 541.6[illegible]

6266. Low frequency coupled oscillator and it[s] application to high polymer study. S. Iwayanagi and T. Hideshima. *J. Phys. Soc. Japan*, **8**, 365–8 (*May–June*, 1953).

For the study of dynamical properties of high polymers by low frequency oscillations, a simple torsional coupled oscillator was constructed in which two pendulums of the same type having equal frequency (about 1/2 c/s) were coupled to each other through a test material of cylindrical shape. Two modes of oscillations appear in the motion of the oscillator, resulting in generating beats under suitable conditions. By observing the beats, it is possible to obtain the shear modulus and the elastic loss of the material through a simple course of calculation. Polymethyl methacrylate was investigated from about −20°c to about 150°c and anomalous absorption ranges were found at about 130°c and at about 20°c. A.

539.373 : 548.0[illegible]

6267. On distortion by compression of long crystals. H. Scholl and F. Röhm. Note in *Naturwissenschaften*, **39**, *No.* 22, 505 (1952) *In German.*

Describes some experiments on aluminium single crystals with various angles between the glide direction and the long axis of the crystal rod. A. R. Stokes

539.373 : 548.0[illegible]

6268. The theory of dislocations in one-dimensional rows of atoms. III. Dislocations, proper motions and their interactions. A. Seeger, H. Donth and A. Kochendörfer. *Z. Phys.*, **134**, *No.* 2, 173–93 (1953) *In German.*

For Pt II, see Abstr. 1243 (1952). An analysis of the interaction between dislocations and sound waves. It is shown that there are combinations of thermal waves which, despite non-linearities in the forces, possess properties reminiscent of eigen-oscillations. By analogy, dislocations are described as translational eigen-motions. Within the framework of Frenkel's dislocation model simple laws for the superposition of eigen-motions are obtained by means

the Bäcklund transformation. It appears that the teraction of such wave groups with dislocations lads to undamped motions in a continuous, 1-dimenonal crystal. W. J. SWIATECKI

539.374

6269. The fundamental laws of flow of amorphous nd crystalline materials. A. KOCHENDÖRFER. Note n *Z. angew. Phys.*, **5**, *No.* 2, 69–80 (1953) *In German.*

A comprehensive survey of the current theoretical xplanations of viscous and plastic flow in terms of nolecular or atomic rearrangements in the material. eferences. J. G. OLDROYD

539.374

6270. On plastic flow. W. KOSSEL. Note in *Z. Naturforsch.*, **8a**, 211–12 (*Feb.–March*, 1953) *In German.*

Plastic flow is considered as a type of crystalline earrangement on the same footing as simple crystal growth. Material breaks away from a severely trained crystal lattice to join a new lattice formation with less potential energy. J. G. OLDROYD

539.374 : 536.48

6271. On the question of structure of metals. V. E. KHOTKEVICH. *Zh. tekh. Fiz.*, **22**, *No.* 3, 474–9 (1952) *In Russian.*

Investigates the structures of Li, Na, Sn, In, Tl, Hg, Cd, Pb and Al submitted to plastic deformation at temperatures of liquid hydrogen and nitrogen. It is shown that under these conditions lithium shows a polymorphic transformation from a body-centred cubic modification to face-centred. The remaining metals maintain their crystal structure. W. BARDSLEY

539.4.016.3 : 539.17

6272. Annealing of bombardment damage in solids. W. L. BROWN, R. C. FLETCHER AND S. MACHLUP. Letter in *Phys. Rev.*, **90**, 709 (*May* 15, 1953).

For the annealing of isolated interstitial vacancy pairs, presumably introduced by bombardment with particles having energies slightly exceeding the threshold values, an analytical expression has been obtained. It has the form of the sum of three different types of terms: N_M (the monomolecular term), N_L (the liberation term) and N_B (the bimolecular term). Expressions for each term are given.

F. LACHMAN

539.4.016.3 : 539.26

6273. Causes of the diffuseness of interference lines in X-ray photographs of quenched carbon-free alloys of iron. L. S. MOROZ. *Zh. tekh. Fiz.*, **22**, *No.* 3, 498–507 (1952) *In Russian.*

The width of the 211 and 110 reflections from 8% chrome steel was measured as annealing at various temperatures proceeded. The specimen had previously been quenched from 1000°. A linear relationship was found between the log. of the time of tempering and the reciprocal of the absolute temperature necessary to produce a given line width. From this the energy of activation of the process of relieving the distortion of the crystal lattice was found to increase with time and according to the nearness of the lattice to the perfect state, tending to a value of about 70 kcal/g. mol. This is near to 78 kcal/g. mol, the energy of activation for volume self-diffusion, and confirms the hypothesis that self-diffusion of the iron atoms is the basic method of relieving the strains. A. L. MACKAY

539.42 : 539.374

6274. The measurement of dynamic strength of plastic materials. F. X. EDER. *Z. angew. Phys.*, **5**, *No.* 1, 1–5 (1953) *In German.*

Experiments in which Cu test-pieces were elongated at rates of strain up to 300 sec^{-1} are in good agreement with Kochendörfer's theory of the increase of tensile strength with rate of strain. The propagation of plastic waves along a test-piece is discussed, and the errors which can result from non-uniformity of stress along the length are demonstrated. These errors can be reduced by increasing the mass attached to the end of the specimen (to which the impulsive force is applied), and can be estimated by observing the permanent deformation of the test-piece after the experiment. J. G. OLDROYD

539.42 : 548.7

6275. On the effect of crystalline structure on the yield point of a polycrystal. P. I. KULESHOV. *Zh. tekh. Fiz.*, **22**, *No.* 7, 1174–83 (1952) *In Russian.*

A general method is presented for calculating the yield point of a polycrystalline substance from the properties of single crystals. Numerical integration is used to find the onset of yield in metals of the copper and iron type in the case of linear and two-dimensional stressed states, which is found to be related to the grain structure. With fine homogeneous grains in complete disorder there may be some cases in which a difference in grain structure will not affect the value of the yield point. A curve is derived on the basis of shear stress theory and found to lie between the Saint Venant and von Mises curves and closer to the latter. A. GELBTUCH

539.434

6276. The creep of zinc single crystals under direct shear. E. H. WEINBERG. *J. appl. Phys.*, **24**, 734–44 (*June*, 1953).

Room temperature measurements on very pure specimens verify the Tyndall law, $s = at^m$, which was determined by tensile measurements. The value of m is approximately 0·6. Discrepancies in tensile creep tests reported by other observers are shown experimentally to be caused most probably by bending of the specimen during the creep process. The Bauschinger effect has also been investigated and creep at the very small stresses needed appears to follow the same creep law. A.

539.533 : 548.0

6277. Mutual grinding of brittle solids. V. D. KUZNETSOV. *Zh. tekh. Fiz.*, **22**, *No.* 9, 1409–27 (1952) *In Russian.*

See also Abstr. 1199 (1953). The author and his school have for nearly 30 years done a great deal of work on Holmquist's method of mutual grinding for determining the hardness of crystals, the relative effectiveness of lubricants on various materials and also of relative values of surface energies of different faces of crystals of the same material. By comparing the results in the last case with the rate of growth of

the crystals, a check on the Gibbs–Curie–Wulff law is obtained. The comprehensive paper presented summarizes methods and results, gives an elementary theory of the mutual grinding of crystals of the halide salts of alkali metals, the results of which may be stated as follows: The energy lost on the mutual grinding is equally distributed between the crystals, and the grain sizes of the powders of the two crystals are equal. In mutual grinding of calcite and rocksalt crystals along the faces (100) and (111) it was found that the ratio of the masses of ground-down layers is independent of the fact whether the operation was carried out directly or by intermediate operations. Mutual grinding of the cubic face of a NaCl crystal with a face at an angle to it confirmed a theoretical formula derived on the assumption that cleavage of the crystal is possible only along cubic faces. Mutual grinding of polycrystalline carbonates of various metals showed that the mass ratio of the ground-down layers in direct grinding is equal to that obtained by grinding on an "intermediate" carbonate crystal. Mutual grinding and drilling operations yield approximately equal relative values of the surface energies of the halide salt crystals of the alkali metals.

B. F. KRAUS

539.

6278. On the sliding of hard bodies on ice. S. Budnevich and B. V. Deryagin. *Zh. tekh. Fiz.*, 2 *No.* 12, 1967–80 (1952) *In Russian.*

Apparatus is described for measuring load ar speed dependence of coeff. of friction (μ) in th temperature range −150° to 0°c, for steel or woo sliders on ice. μ rises approx. linearly from boundar value ($\sim 0{\cdot}03$) near 0°c to dry value ($\sim 0{\cdot}4$) −150°c. At fixed temperature near 0°c μ increase to $\sim 0{\cdot}10$ as the specific load is reduced to zer below 150 g/cm^2. Results are explained if it assumed that some of the asperities on the ice surfac melt by frictional heating if they are greater tha critical size. The temperature rise is deduced fro the theory of Blok (1937). Water forms a boundar lubricating layer and μ obeys Amonton's law, so flui lubrication is not achieved. Theory permits the pre diction of temp. dependence (in range −150° to 0°c) c μ for any load on a given ice surface, provided de pendence has been measured at one load. μ de creases slightly as speed of sliding increases from zer but remains constant for speeds above 0·2 m/sec, i contradiction with theory which predicts a con tinuous fall of μ with increasing speed. J. W. MENTE

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123 : 542.46

6279. Apparatus for rapid determination of liquid–liquid and liquid–solid equilibria involving corrosive materials. W. Davis, Jr, L. L. Conley and G. P. Rutledge. *Rev. sci. Instrum.*, **24**, 431–2 (*June*, 1953).

An apparatus has been built for measurement of temperatures at which phase changes (precipitation of solid or liquid from a homogeneous solution) are visually observed to occur. This apparatus was constructed for use with corrosive chemicals, such as anhydrous hydrogen fluoride, which are contained in a Fluorothene tube. The tube has appropriate thermal shielding and is shaken vigorously to allow relatively large rates of heating and cooling. Precisions of temperature measurement in the order ±0·5°c are attainable.

A.

541.124

6280. The reactions of methyl radicals with the hydrogen isotopes. E. Whittle and E. W. R. Steacie. *J. chem. Phys.*, **21**, 993–9 (*June*, 1953).

The photolysis of acetone has been studied in the temperature range 130–420°c. Measurements have been made of the rates of most of the possible reactions of CH_3 and CD_3 radicals with hydrogen, deuterium and deuterium hydride. The following activation energies for the abstraction of a hydrogen or deuterium atom have been found: CH_3 + acetone, 9·7; CD_3 + *d* acetone, 11·6; $CH_3 + D_2$, 11·8; $CD_3 + H_2$, 11·1; $CH_3 + HD \rightarrow CH_4$; 10·0; $CH_3 + HD \rightarrow CH_3D$, 11·3; $CD_3 + HD \rightarrow CD_3H$, 10·7; $CD_3 + HD \rightarrow CD_4$, 10·7 kcal. The steric factor are all of the order of 10^{-3}. The results are discussed in terms of isotope effects with particular reference to the deuterium hydride reactions.

A

541.12

6281. The mechanism of unimolecular reactions. L. S. Kassel. *J. chem. Phys.*, **21**, 1093–7 (*June* 1953).

The general theory of unimolecular reactions is re examined to determine what type of information about rate constants for specific activated states may be determined from the experimental reaction rate-pressure curves. It is found that the possibilities in this respect are very limited. Contrary to a recent statement by Johnston, data on decomposition of nitrogen pentoxide in the presence of nitric oxide are adequately fitted by the Kassel theory. Data on decomposition of nitrous oxide, however, cannot be fitted by this theory. Failure of the theory in this case is the result of too small a range of decomposition rate constants for various activated states.

A.

541.124 : 536.7

6282. A thermodynamic investigation of the solid-phase reactions in the system; calcium oxide–silica. N. A. Landiya and O. P. Mchedlov-Petrosyan. *Zh. fiz. Khim.*, **26**, *No.* 12, 1785–90 (1952) *In Russian.*

From published thermodynamic data the change in free energy is calculated and plotted against temperature for 11 reactions between SiO_2, CaO and their anhydrous compounds. The results give a quantitative explanation of the order of formation of various compounds and clear up seeming inconsistencies in the results of certain other authors.

A. L. MACKAY

541.126

:83. The determination of the reaction constants r the formation of mercury complexes by conduc- ity measurements. G. ELLENDT AND K. CRUSE. . *phys. Chem.*, **201**, *No.* 3–4, 130–60 (*Dec.*, 1952) *In erman.*

541.127

284. Kinetics of the formation of methaemoglobin ide. R. HAVEMANN AND W. RAUSCH. *Z. phys. hem.*, **201**, *No.* 3–4, 111–20 (*Dec.*, 1952) *in German.* The reaction rate of the formation of methaemo- lobin azide from methaemoglobin and azide ions as been investigated at 20°c and at various values of H. The reaction has an initial phase during which he velocity of reaction is very slow and then during a eriod of 30 to 90 sec the velocity increases to a naximum. It is concluded that during this initial hase the azide ions are diffusing into the interior of he protein molecule and it seems that the binding of he azide ions to the prosthetic groups of the methae- noglobin cannot take place until this penetration has aken place. The velocity of the binding of the azide ons is found to be proportional to pH. J. IBALL

541.128

5285. Effect of the electronic disorder in oxidic catalysts on the rate of decomposition of nitrous oxide. H. HAUFFE, R. GLANG AND H.-J. ENGELL. *Z. phys. Chem.*, **201**, *No.* 5–6, 223–45 (*Dec.*, 1952) *In German.*

Presents the results of an investigation on the decomposition of N_2O on oxidic catalysts for which the electronic disorder is known, in particular on ZnO, CuO, Cr_2O_3 and NiO, with admixtures [impurities]. Results obtained, and those of investigations by other authors show that the rate of decomposition of N_2O on ZnO and on pure NiO is determined by desorption. Points to the possibility of deriving from the electronic disorder data for the different oxides an acceptable explanation of the catalytic behaviour of oxides of different conductivity types. Stresses the importance of electron-defect sites in the catalyst for the desorption process, hence for the total reaction of decomposition. F. LACHMAN

ELECTROCHEMISTRY 541.13

541.13

6286. Coefficient of activity of strong electrolytes as function of concentration. E. WICKE AND M. EIGEN. Note in *Naturwissenschaften*, **39**, *No.* 11, 545–6 (1952) *In German.*

Three graphs show the dependence of the mean coefficients of activity for strong electrolytes upon their concentration, as obtained from a new relationship based on a recent paper [Wicke and Eigen, *Z. Elektrochem.*, **56**, 551 (1952)]. The new equation contains an empirical constant, the "mean hydrate radius," and the graphs for the 1–1, 2–1 and 3–1 electrolytes contain curves for different values of this constant. F. LACHMAN

541.133

6287. Conductivity of strong electrolytes with respect to superposed alternating fields. M. BONNEMAY AND J. VERGNOLLE. Note in *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 235–6 (*Sept.*, 1952) *In French.*

Experimental results are recorded of the conductivities of various electrolytes (e.g. $K_4Fe(CN)_6$, Na_3PO_4, K_3PO_4, KCl, etc.), when measured by means of an electrical field of a given frequency in presence of one of different frequency. A purely additive law is deduced, the conductivity at a given frequency being totally independent of the presence of the field of different frequency. These results appear difficult to interpret in the light of the Debye–Falkenhagen dispersion theory. H. H. HODGSON

541.133

6288. Electrical conductivity of cation exchange membranes. G. MANECKE. *Z. phys. Chem.*, **201**, *No.* 5–6, 193–210 (*Dec.*, 1952) *In German.*

A description is given of the preparation of membranes for kation exchange, which are composed of phenolsulphonic acid condensates with formaldehyde, and of sulphonated styrene-divinylbenzene compositions respectively. Their specific electrical conductivities are measured in KCl solutions of various concentrations; and comparison made with conductivities calculated from concentrations and ionic mobilities in the membranes, this data being obtained experimentally. The convection conductivities of the membranes are low relative to the normal electrolytic conductivities. The average activity coefficients of the exchange ions are given by concentration determination of the K-ions for high external ionic concentrations. Measurements of the membrane potentials afforded the average activity coefficients for low external concentrations, from which the equilibrium constant for the $K \rightarrow Na$ exchange is calculated and found to agree with the experimental value.

H. H. HODGSON

541.135

6289. Experimental study of the electrolysis of aqueous solutions of cadmium sulphate by alternating current. M. BONNEMAY AND J. VERGNOLLE. *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 271–81 (*Dec.*, 1952) *In French.*

Deformations of voltage-current curves are recorded as functions of sinusoidal voltages superposed during the electrolysis of aqueous solutions of cadmium sulphate, and of frequencies and phase alterations between 50 c/s and 350 Mc/s. The results are discussed, and it is found that for certain regions the curves $I(t)$ are made up of purely sinusoidal parts which enable dephasing to be expressed simply with respect to voltage. The non-reversible character of the current-voltage curve, as traced by the oscillograph, is explained by the existence of this dephasing. The results admit of qualitative generalization. Experimental details are included with 14 diagrams, curves, etc., and 32 refs. H. H. HODGSON

541.135

6290. On the distribution of ions in electrolytic solutions. M. DUTTA. Note in *Naturwissenschaften*, **40**, *No.* 2, 51–2 (1953).

A reply to what are stated to be misleading remarks of Wicke and Eigen [Abstr. 5381 (1952)] on the author's note [Abstr. 5380 (1952)] on strong electrolytes in solution, which takes the form of a report on

the equivalence of the Dutta–Bagchi formula [Abstr. 7559 (1950)] and formulae used by Eigen and Wicke [Abstr. 3967 (1952)]. It is shown that the Dutta–Bagchi formula is neither a special case of nor derivable from Fermi–Dirac statistics as stated by Wicke and Eigen. It is asserted also that from the formula a method may be developed which yields the D.H. limiting laws, and agrees with experiments of activity-coefficients of which data are included.

H. H. HODGSON

541.135

6291. Diffuse double layer theory for electrolytes of unsymmetrical valence types. D. C. GRAHAME. *J. chem. Phys.*, **21**, 1054–60 (*June*, 1953).

Equations are derived for the variation of potential with distance and for the components of charge and capacity in the diffuse double layer at a plane interface for electrolytes of the 1 : 2 and 2 : 1 valence types. Some additional relations are also deduced for other valence types.

A.

541.135.5

6292. Membrane accumulator. G. MANECKE. *Z. phys. Chem.*, **201**, 1–15 (*Nov.*, 1952) *In German.*

The membrane accumulator described is obtained by arranging alternately cation, and anion, exchange membranes. If all interspaces are filled with an electrolyte solution of the same concentration, and a direct current is conducted through this setup, alternate dilutions and concentrations of solutions occur owing to the different membrane permeability. Thus membrane potentials are obtained. When current is taken from the accumulator, the concentration differences gradually decrease. The charging and discharging processes have been treated theoretically and investigated experimentally, and the measurements have been compared with the theory. The validity of Ohm's law for the potential drop within the membrane accumulator has been checked.

F. LACHMAN

541.135.5

6293. Alternating current polarization of electrodes with a potential-defined step at the equilibrium potential. II. H. GERISCHER. *Z. phys. Chem.*, **201**, 55–67 (*Nov.*, 1952) *In German.*

Previous work [Abstr. 2197 (1952)] is extended to the influence of heterogeneous reactions on the kinetic polarization. The examples discussed are the effect on the structure of the metallic lattice of the electrode, and on a general heterogeneous reaction with diffusion of the reaction partners in the electrolyte. The discharge of a complex ion is treated as an example of an heterogeneous reaction with simultaneous exchange of charge.

H. H. HODGSON

541.135.7

6294. Effect of an a.c. component on the distribution of the current in galvanic electrolytes. J. STEINER. *Z. phys. Chem.*, **201**, *No.* 3–4, 161–7 (*Dec.*, 1952) *In German.*

The effect of an a.c. component superposed on d.c. has been investigated by means of a cathode-ray oscillograph and found to be characterized by (1) the ratio of the constant-voltage component of the cathodic polarization in an undulating current to the d.c. cathodic polarization, (2) the undulation of cathodic polarization, and (3) the shape of the a.c. component curve.

F. LACHMAN

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.1

6295. On the inflammability of explosives by radiation of high intensity. J. BERCHTOLD AND J. EGGERT. Note in *Naturwissenschaften*, **40**, *No.* 2, 55–6 (1953) *In German.*

Comparative figures are given of the loading in W.sec necessary in a xenon flash tube to ignite various explosives under similar conditions. Dark coloured substances are most sensitive. The loading decreases linearly with increase of ambient temp. in the case of lead azide.

S. T. HENDERSON

541.14

6296. The photochemical decomposition of benzene. G. E. GIBSON, N. BLÅKE AND M. KALM. *J. chem. Phys.*, **21**, 1000–4 (*June*, 1953).

Under intense ultraviolet illumination with an A–H6 mercury arc, benzene solutions in rigid glass at liquid air temperatures are decomposed. If the solvent molecules contain hydrogen, hexatriene is formed (almost certainly identified by absorption spectrum and chemical behaviour). In a solvent (perfluoro-2-methyl pentane) containing no hydrogen, the benzene decomposes to an entirely different product, not as yet certainly identified.

A.

541.144

6297. The photochemical decomposition of azomethane. M. H. JONES AND E. W. R. STEACIE. *J. chem. Phys.*, **21**, 1010–25 (*June*, 1953).

The photolysis of azomethane has been investigated over the temperature range 24–190°C. The variation in the rates of production of nitrogen, methane and ethane with absorbed intensity, azomethane concentration and temperature may be accounted for quantitatively by the reactions $CH_3N = NCH_3 + h\nu \rightarrow N_2 + 2CH_3$, $CH_3 + CH_3N = NCH_3 \rightarrow CH_4 + CH_2N = NCH_3$, $CH_3 + CH_3 \rightarrow C_2H_6$. The quantum yield of nitrogen formation was found to be unity and independent of temperature. For the activation energy difference $E_2 - \frac{1}{2}E_3$ a value of 7·6 kcal/mole was obtained. Evidence is cited for an association reaction between methyl radicals and azomethane. On the basis of an assumed mechanism, the activation energy of this process is 6·4 kcal/mole.

A.

541.14 : 534.23

Sonochemistry: the production of chemical changes with sound waves. *See Abstr.* 5923

541.15

6298. Theory of radiation chemistry. II. Track effects in radiolysis of water. A. H. SAMUEL AND J. L. MAGEE. *J. chem. Phys.*, **21**, 1080–7 (*June*, 1953).

For Pt I see Abstr. 9071 (1951). A model is presented which describes the geometrical effects in the radiolysis of water as a result of the diffusion of free radicals. The motion of secondary electrons immediately following the passage of the ionizing particle is discussed in an appendix, and it is concluded that

dicals are most likely formed in pairs at the approximate sites of the original ionizations. Models for the ffusion of these radicals are shown to result in a finite fraction of radicals which undergo initial recombination for γ- and fast β-rays, for which the ours are considered as diffusing independently. For rays a connected-track model is used. For the ntermediate case of tritium β-rays a two-stage model constructed. In each case the comparative yields f the "forward" and "radical" reactions (G_F and G_R) are calculated. Subsequent chemical effects in ure water and solutions are also considered briefly.

A.

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.183

6299. Adsorption of *n*-pentane, *n*-propyl chloride and other vapours on metallic zinc and on thin films of zinc phosphate. W. RAUSCH. *Z. phys. Chem.*, **201**, 32–54 (*Nov.*, 1952) *In German.*

Adsorption isotherms of *n*-pentane, *n*-propyl chloride, ethyl ether and carbon tetrachloride were measured on (I) etched zinc, and (II) on zinc covered with a thin layer of zinc phosphate. The surface area (calculated by the BET and Hüttig isotherms) of II was 5–6 times that of I, and the integral heat of adsorption for two molecular layers was 10–25% higher on II than on I, pointing to an increase in surface energy, important for the protective action of the phosphate. The variation in heat of absorption with surface coverage is discussed in relation to the mutual interaction of the adsorbed molecules and to the heterogeneity of the surface. Adsorption isotherms on II were measured after heating to 100°, 150°, 200°, 250° and 300°C. The form of the curve of heat of adsorption against surface coverage alters at 200° and at 300°C. The first is related to the dehydration of the zinc phosphate. S. J. GREGG

541.183

6300. Electronic interaction between chemisorbed molecules and adsorbing surface. R. SUHRMANN AND K. SCHULZ. Note in *Naturwissenschaften*, **40**, *No.* 4, 139–40 (1953) *In German.*

The change in electrical resistance R of vacuum-evaporated Ni films in the presence of (I) N_2O, CO, (II) H_2O, C_6H_6, $CH(C_6H_5)_3$, $C_{10}H_8$, has been measured. (I) increase R because they decrease the concentration c of electron gas in the metal, and (II) decrease R because they increase c. S. J. GREGG

CHEMICAL STRUCTURE 541.2/.6

541.57

6301. Electron deficient compounds. VII. The structure of the trimethylaluminum dimer. P. H. LEWIS AND R. E. RUNDLE. *J. chem. Phys.*, **21**, 986–92 (*June*, 1953).

For Pt VI see Abstr. 3089 (1952). The trimethylaluminium dimer has a bridge structure with a skeletal symmetry of D_{2h} within the accuracy of a structure determination by X-ray diffraction of single crystals. Bridge bonds, Al–C, equal 2·24 Å, *v.* Al–C bonds of 1·99 Å for the exterior, "normal" methyls. The bridge angle, Al–C–Al = 70°, the exterior ∠ C–Al–C = 124°. It is shown that a simple model provides the right order of magnitude for the heat of dimerization, and indicates the relative importance of Al–C and Al–Al bonds. It is suggested that the sharp bridge angle required for good bridge bonding leads to metal-metal repulsions which should increase as the size of the metal increases. This probably plays a role in the instability and nature of polymers of the heavier trialkyl-metal compounds. A.

541.64 : 532.133

6302. The effect of inhomogeneity on the relation between viscosity and molecular weight for polymer solutions. G. MEYERHOFF. Note in *Naturwissenschaften*, **40**, *No.* 3, 106–7 (1953) *In German.*

Experiments on polymethyl acrylate solutions show that the constancy of a in the relation $\eta = \text{const.}\ M^a$ is genuine and is not due to inhomogeneity. The result then stands in contradiction with theory.

R. O. DAVIES

541.64 : 536.41

6303. The thermal expansion of high polymers. K. ALTENBURG. *Z. phys. Chem.*, **201**, 75–90 (*Nov.*, 1952) *In German.*

With a number of references to the author's previous work, calculations are given using the observations of Uberreiter and Kanig [Abstr. 2218 (1952)]. T. C. TOYE

541.64 : 536.653

6304. Heat of solution and phase change in polystyrenes. K. VON GÜNNER AND G. V. SCHULZ. Note in *Naturwissenschaften*, **40**, *No.* 5, 164 (1953) *In German.*

Correlations between the calorimetrically determined heats of solution of polystyrenes (of 5 degrees of polymerization, ranging from 20 to 87) in 3 solvents, on the one hand, and the degree of polymerization, or temperature, on the other, agree well with the hypothesis that the heat of solution of polymers consists of that of the low-molecular compound (monomer) plus the energy of interaction between the solvent and the polymer. F. LACHMAN

541.64 : 539.32

Dynamical study on the secondary anomalous absorption region of polymethyl methacrylate. *See Abstr.* 6265

541.64 : 539.32

Low frequency coupled oscillator and its application to high polymer study. *See Abstr.* 6266

CRYSTALLOGRAPHY 548

548.0 : 539.373

On distortion by compression of long crystals. *See Abstr.* 6267

548.0 : 539.373

The theory of dislocations in one-dimensional rows of atoms. *See Abstr.* 6268

548.5

6305. On the theory of crystallization. V. N. RODIGIN. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1356–61 (1952) *In Russian.*

A. N. Kolmogorov's theoretical description of crystallization from a solution (1937) has been repeated with less stringent assumptions. These are: crystals are convex, having identical orientations, and grow retaining their initial shapes; the volume ratio of crystallized material to initial total volume is equal to the probability with which a randomly chosen point lies in the crystallized mass. Expressions are derived for the number of centres, the mean volume and dimensions of crystals at any time, and for the rate of nucleation. A. L. MACKAY

548.5 : 621.318.1

6306. The preparation in sheet form of large single crystals of silicon-iron of predetermined orientation for magnetic purposes. R. G. MARTINDALE AND D. A. LANGFORD. *Proc. Instn Elect. Engrs, II*, **100**, 417–26 (*Aug.*, 1953).

The use of the strain-anneal method is described in detail. Whole-sheet single crystals up to $2\frac{3}{4}$ in. wide and 21 in. long, and having a crystallographic plane either of the form {100} or {110} in the plane of the sheet, have been made successfully from 2% silicon commercial electrical sheet using Dunn's method. Certain limitations in the orientations it was possible to produce by this means were observed with the materials used, attempts to grow crystals having a {111} in their plane, for example, being unsuccessful. The many factors affecting recrystallization are discussed. Carbon contents of the order of 0·015% were observed in several of the crystals prepared. One of the crystals with a silicon content of 2·11% exhibited no phase change up to a temperature of 1140°C, i.e. 40–50°C above the temperature at which it was grown, and examination by X-rays showed it to be of exceedingly high quality with an estimated range of misorientation of not more than ten minutes of arc. A magnetic torque curve for a $1\frac{1}{4}$-in. dia. single-crystal disk having a {100} cube face in its plane is given, and the magnetization curve in the ⟨100⟩ direction for a "picture-frame" sample of external dimensions $1\frac{7}{16}$-in. square is also included. The former shows that it is more accurate to take a figure of 89% of the unique infinite field value of the anisotropic constant K_1 when analysing torque curves obtained on 0·014-in. thick disks of $1\frac{1}{4}$-in. dia. in applied fields of the order of 2000 oersteds, and this figure is in good agreement with the correction suggested by Tarasov. A.

548.538 : 548.74 : 539.232

6307. On the structure of thin zinc-oxide layers on zinc single-crystal surfaces. H. EHLERS AND H. RAETHER. Note in *Naturwissenschaften*, **39**, *No.* 2 487–8 (1952) *In German.*

Electron-diffraction photographs show that simil symmetries and nearly equal lattice constants are n the only conditions needed for one substance to for a crystal lattice fitting on to a single crystal of anothe A. R. STOKE

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.

6308. On the decrease in crystal density due t colour centres. H. WITT. *Nachr. Akad. Wiss Göttingen, Math.-phys. Kl. IIa*, **1952**, *No.* 4, 17–20. *I German.*

Changes in density of less than 10^{-3}% are measure by immersing a rectangular block of crystal in a liquid of equal density. The crystal has only one half coloured by X-rays. This half is less dense and the crystal sets with the coloured half upwards. The rate of rotation into this position gives a means of estimating the difference in density between coloured and uncoloured portions. Results for *F*-centre concentrations in two crystals of KCl obtained from density changes agree with those from absorption spectra of the coloured crystals. G. F. J. GARLICK

548.7

6309. Deviations from Brillouin's free-spin theory in manganese fluosilicate. R. C. O'ROURKE. *Phys. Rev.*, **90**, 786–90 (*June* 1, 1953).

A method is proposed which allows one to calculate the magnetic moment of a paramagnetic ion in a crystalline electric field. The case of manganese fluosilicate is examined since one has complete information on the paramagnetic resonance spectrum of this salt. The result is that there are measurable deviations from the Brillouin free-spin theory due almost entirely to the trigonal part of the crystalline electric field (*D* term in Abragam-Pryce Hamiltonian) in the neighbourhood of 1°K. A.

548.7

6310. The mutual polarization of ions in lattices. T. NEUGEBAUER. Note in *Naturwissenschaften*, **40**, *No.* 1, 18 (1953) *In German.*

The potential of an ion due to the field of neighbouring ions is expanded in Legendre functions. The zero and first-order terms disappear for all ionic lattices, and following terms are dependent on the crystal symmetry. An explanation is given of the expansion and contraction of ions as found by Fajans and Joos [*Z. Phys.*, **23**, 1 (1924)]. C. TURNER

548.7

6311. On the mechanism of the discoloration of alkali halide layers by cathode rays. K. H. J. ROTTGARDT. Note in *Naturwissenschaften*, **40**, *No.* 6, 199 (1953) *In German.*

A relation between the colour contrast of an evaporated KCl screen and the number of incident electrons is derived by considering both the formation

colour centres by the trapping of electrons excited o the conduction band, and the discoloration of sting centres by the release of trapped electrons. e theoretical curve agrees with experimental ults up to a charge density of 10 μC/cm^2.

J. FRANKS

548.7

12. Energy band structure in silicon crystal. YAMAKA AND T. SUGITA. Letter in *Phys. Rev.*, **90**, 2 (*June* 1, 1953).

Using the method of cubic harmonics, following n der Lage and Bethe, the energy band structure silicon has been calculated. As regards the values energy gap and band width, improved agreement th experiment has been attained.

P. T. LANDSBERG

548.7 : 535.342/.343

On the temperature dependence of electron levels in ystals. *See Abstr.* 5952

548.7 : 535.343.2–15

13. On the positions of hydrogens in the lattices crystalline hydroxides. E. HARTERT AND O. LEMSER. Note in *Naturwissenschaften*, **40**, *No.* 6, 9–200 (1953) *In German.*

A smooth curve is obtained relating experimental sults for the i.r. absorption maximum for OH brations with the effective OH-ion radius, for a ries of hydroxides of metals. A. R. STOKES

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See bstr.* 6249–60

548.733

14. Experimental realization of dynamic reflec- n curves of ideal crystals with monochromatic -radiation. M. RENNINGER. Note in *Naturwissen- haften*, **40**, *No.* 2, 50 (1953) *In German.*

Two calcite crystals are used in the (1, +1) position produce a highly monochromatic and highly llimated beam; this is reflected by a third crystal, hose reflecting curve is required, into a counter be. A. R. STOKES

548.735

15. On the possibility of determining the sym- etry of a crystal by X-ray structural analysis. J. C. WILSON. Letter in *Zh. fiz. Khim.*, **26**, *No.* 10, 41 (1952) *In Russian.*

Reply to comments by Kitaigorodskiĭ [*Zh. fiz. him.*, **25**, 127 (1951); see also Abstr. 2171 (1951)] n the difficulty of distinguishing true and pseudo ntres of symmetry. Attention is drawn to work y Wilson) on the departure from centrosymmetric atistics of high-angle reflections in certain crystals hich show centrosymmetric statistics for low-angle roups. Phosphorus triphenyl is now ascribed to ie space group $P2_1/a$. A. L. MACKAY

548.736.3

16. The structure of the α-modification of lead oxide. A. I. ZASLAVSKIĬ AND S. S. TOLKACHEV. *h. fiz. Khim.*, **26**, *No.* 5, 743–52 (1952) *In Russian.*

Crystals of α — PbO_2, deposited electrolytically on t, Ni or Fe anodes were found to be orthorhombic ith $a = 4{\cdot}937$, $b = 5{\cdot}939$ and $c = 5{\cdot}486$ kX. The pace group is *Pbcn* and $Z = 4$. The structure para- eters are Pb, $y = 0{\cdot}178$; O, $(x, y, z) = (0{\cdot}276, -0{\cdot}410, 0{\cdot}425)$. The packing system is based on O octahedra, sharing an edge in pairs, built into chains of alternately single and double links by the sharing of a second edge, adjacent to the first, by each octahedron. The texture of the deposit is such that the [100] direction is normal to the anode plane, there being a scatter of $\pm 3{\cdot}5$–4° in the preferred axis. The structure is related closely to that of columbite, $FeNb_2O_6$. A. L. MACKAY

548.736.3

6317. On the structure and synthesis of niobium–nitrogen compounds. G. BRAUER, J. JANDER AND H. RÖGENER. *Z. Phys.*, **134**, *No.* 4, 432–4 (1953) *In German.*

See also Rögener [Abstr. 8872 (1952)]. Results of previous experiments are compared. It is found that at a reaction temperature above 1300° the lattice structure of NbN depends on the amount of nitrogen: a tetragonal face-centred structure is formed for higher N contents, a cubic face-centred structure for lower N contents. Mixtures of both lattices occur and the tetragonal crystals also contain some Nb_2N.

A. J. TAYLOR

548.736.4

6318. Thermal and X-ray analysis of the system LiF–BeF_2. A. V. NOVOSELOVA, YU. P. SIMANOV AND E. I. YAREMBASH. *Zh. fiz. Khim.*, **26**, *No.* 9, 1244–58 (1952) *In Russian.*

LiF undergoes a polymorphic transition at 827° and melts at 845°. Li_2BeF_4 melts with decomposition at 461° and $LiBeF_3$ similarly at 353°. $LiBe_2F_5$ decomposes at 277°. A double fluoride $5LiF \cdot BeF_2$ (or $4LiF \cdot BeF_2$) probably exists. Li_2BeF_4 transforms at 178° (α to β) and 362° (β to γ). Its low-temperature (α) form has cell dimensions $a_{rh} = 8{\cdot}120 \pm 0{\cdot}002$ Å and $\alpha = 107°\ 36'$. The γ-form is cubic with $a = 6{\cdot}08 \pm 0{\cdot}02$ Å. BeF_2 melts to a glass softening about 577°. In melts with LiF, BeF_2 undergoes polymorphic transitions at 217° (α to β) and 337° (β to γ). The form of BeF_2 stable above 337° is hexagonal and quartz-like with $c = 5{\cdot}15$ Å and $a = 4{\cdot}74$ Å. Alloys with > 65% BeF_2 seem to contain a further modification of BeF_2 as well as γ — BeF_2. Resemblances are expected to Zn and Mg silicates. (Temperatures are all ± 5°). A. L. MACKAY

548.736.4

6319. The high-temperature form of calcium, strontium and barium sulphate. O. W. FLÖRKE. Note in *Naturwissenschaften*, **39**, *No.* 20, 478–9 (1952) *In German.*

Measurements in a high-temperature X-ray camera from 500° to 1300°C. The transition from β– to α–$CaSO_4$ occurs between 1180° and 1220°C. There are similar intervals for $SrSO_4$ and $BaSO_4$. α–$CaSO_4$ has a similar structure to α–$NaClO_4$. A table of the main lines for the three substances is given.

C. TURNER

548.736.5

6320. Electronographic determination of the structure of $NiCl_2 \cdot 2H_2O$ and the crystal chemistry of compounds of this type. B. K. VAINSHTEĬN. *Zh. fiz. Khim.*, **26**, *No.* 12, 1774–84 (1952) *In Russian.*

From oblique electron diffraction texture photographs the cell size and space group were obtained

and the intensities of more than 100 reflections ($d > 1{\cdot}0$ kX) were estimated visually. $a = 6{\cdot}970 \pm 0{\cdot}01$, $b = 6{\cdot}900 \pm 0{\cdot}01$ and $c = 8{\cdot}818 \pm 0{\cdot}012$kX; $\beta = 91°31' \pm 10'$. With $Z = 4$ ρ calc. $= 2{\cdot}60$, as compared with ρ meas. $= 2{\cdot}56$. The space group is $I2/m$. Fourier projections on the xz and yz planes, using phases calculated by comparison with the $CoCl_2 . 2H_2O$ structure gave the atomic coordinates:— Ni at 000, $0\frac{1}{2}0$, and parameters (x, y, z) for Cl_I ($0{\cdot}240$, $\frac{3}{4}$, $0{\cdot}040$); for Cl_{II} ($0{\cdot}245$, $\frac{3}{4}$, $0{\cdot}003$); for H_2O ($-0{\cdot}014$, $0{\cdot}024$, $0{\cdot}230$). The structures of the analogous chlorides of Mn, Co, Ni and Cu and $CdCl_2 . 2NH_3$ can be interpreted in terms of the stacking in different ways of chains of octahedra joined by opposite edges. These octahedra each have the metal atom at the centre, H_2O at each of the two free vertices and Cl at each of the four shared vertices.

A. L. MACKAY

548.737

6321. An X-ray study of the crystal structure of *o*-iodobenzoic acid. T. L. KHOTSYANOVA AND YU. T. STRUCHKOV. *Zh. fiz. Khim.*, **26**, *No.* 5, 642–3 (1952) *In Russian.*

Using a de Jong and Bouman camera, crystals were found to be monoclinic, with space group $P2_1/a$ and cell dimensions $a = 11{\cdot}30 \pm 0{\cdot}03$, $b = 15{\cdot}12 \pm 0{\cdot}06$, $c = 4{\cdot}37 \pm 0{\cdot}01$ Å; $\beta = 90° \pm 30'$, $\rho_{obs} = 2{\cdot}249$, $\rho_{calc} = 2{\cdot}221$, $Z = 4$. An ($hk0$) Patterson projection gave the positions of the I atoms, but the lighter atoms were not resolved in the subsequent ($hk0$) Fourier projection. The I atom parameters (x, y) were found to be ($0{\cdot}139 \pm 0{\cdot}000$, $0{\cdot}0784 \pm 0{\cdot}0005$).

A. L. MACKAY

548.737

6322. An X-ray study of crystals of diphenyliodonium iodide. T. L. KHOTSYANOVA AND YU. T. STRUCHKOV. *Zh. fiz. Khim.*, **26**, *No.* 5, 644–6 (1952) *In Russian.*

Crystals were monoclinic, with space group $C2/c$ and unit cell dimensions $a = 22{\cdot}08 \pm 0{\cdot}10$, $b = 6{\cdot}27 \pm 0{\cdot}04$, $c = 20{\cdot}42 \pm 0{\cdot}08$ Å; $\beta = 101° \pm 1°$; $Z = 8$, giving a packing coefficient of $0{\cdot}613$. An ($h0l$) Patterson projection gave the positions of the I atoms, but even in an ($h0l$) Fourier projection, using the calculated phases of the I atoms, the lighter atoms were not properly resolved (diagram given). The (x, z) parameters of the I atoms were found to be ($0{\cdot}151 \pm 0{\cdot}002$, $0{\cdot}145 \pm 0{\cdot}002$) and ($0{\cdot}167 \pm 0{\cdot}002$, $0{\cdot}907 \pm 0{\cdot}002$).

A. L. MACKAY

548.737

6323. An X-ray study of the crystal structure of diphenyliodonium chloride. T. L. KHOTSYANOVA AND YU. T. STRUCHKOV. *Zh. fiz. Khim.*, **26**, *No.* 5, 669–71 (1952) *In Russian.*

Crystals were isomorphous with those of the iodide, being monoclinic with space group $C2/c$ and cell dimensions $a = 20{\cdot}66 \pm 0{\cdot}06$, $b = 5{\cdot}82 \pm 0{\cdot}02$, $c = 20{\cdot}11 \pm 0{\cdot}07$ Å; $\beta = 102°40' \pm 1°$. $\rho_{obs} = 1{\cdot}67$, $\rho_{calc} = 1{\cdot}78$ with $Z = 8$. An ($h0l$) Patterson projection enabled the I and Cl atoms to be located. The subsequent ($h0l$) Fourier projection failed to resolve the lighter atoms. 157 reflections were included in the summation and a temperature factor $\exp[-3(\sin^2\theta)/\lambda^2]$ was applied. The diagram is reproduced. The (x, z) parameters of the I and Cl atoms were found to be ($0{\cdot}143$, $0{\cdot}130$) and ($0{\cdot}$ $0{\cdot}911$) respectively.

A. L. MACK

548.3

6324. The X-ray study of crystals of certain ni and halogen derivatives of benzene and naphthald G. A. GOLDER, G. S. ZHDANOV, M. M. UMANS AND V. P. GLUSHKOVA. *Zh. fiz. Khim.*, **26**, *No.* 1259–65 (1952) *In Russian.*

The unit cells and space groups of the cryst examined were found to be as follows (dimensio a, b and c given in that order. ρ = measured densit 1,8-dichloronaphthalene, $11{\cdot}5$, $10{\cdot}6$, $7{\cdot}9$ kX; β 110°; $\rho = 1{\cdot}51$; $P2_1/c$. 2,6-dichlor-1-nitrobenze $5{\cdot}82$, $9{\cdot}33$, $14{\cdot}2$ kX; $\beta = 91°$; $\rho = 1{\cdot}46$; $P2_1/m$ $P2_1$. 2,4,6-tribrom-1-nitrobenzene, $9{\cdot}3$, $12{\cdot}4$, $9{\cdot}8$ k $\beta = 127°21'$; $\rho = 2{\cdot}46$; $A2_1/a$ or Aa. Benzophenor $8{\cdot}0$, $10{\cdot}2$, $12{\cdot}2$ kX; $\rho = 1{\cdot}1$; $P2_12_12_1$. 1,3,5-trinitr benzene, $12{\cdot}8$, $27{\cdot}0$, $9{\cdot}8$ Å; $Z = 16$; Pcab. 1,3,6 tetranitronaphthalene is orthorhombic with $a = 52$ $b = 15{\cdot}5$ and $c = 5{\cdot}54$ kX, but certain reflectio are diffuse. If these are neglected the a and b dime sions will be half those stated. Crystallization fro various solvents affects the diffuse reflections and th cell size. Similar effects are observed in 2,4, trinitrotoluol.

A. L. MACKA

548.73

6325. A study of the crystalline structure of trichlor benzonitrile. G. A. GOLDER, G. S. ZHDANOV AN M. M. UMANSKIĬ. *Zh. fiz. Khim.*, **26**, *No.* 10, 1434– (1952) *In Russian.*

Crystals are monoclinic with space group $P2_1/$ and cell dimensions $a = 4{\cdot}10$, $b = 15{\cdot}92$ an $c = 12{\cdot}81$ kX, $\beta = 91°30'$. $Z = 4$ and $\rho = 1{\cdot}67$ The molecules lie approximately parallel to the 10 plane being rotated by 21° about their diad axe (the p–Cl to CN lines). These diad axes make angle of 54°30′ with the [010] direction. The benzene ring is slightly distorted the mean C–C distance being $1{\cdot}39_3$kX. The C of the CN group is $1{\cdot}47_5$kX from the neighbouring C atom which is $1{\cdot}39$ kX from the next. The remaining C–C distances are, in order $1{\cdot}40_8$ and $1{\cdot}38_1$kX.

A. L. MACKAY

548.74

6326. Dynamical theory of electron diffraction for finite polyhedral crystal. III. Fresnel diffraction for mula. N. KATO. *J. Phys. Soc. Japan*, **8**, 350–9 (*May– June*, 1953).

For Pt II, see Abstr. 7725 (1952). Following the first paper of the same title [Abstr. 7724 (1952)], in which Bethe's dynamical theory of electron diffraction was extended to the case of a finite polyhedral crystal and the general expressions of wave functions for transmitted and interfracted (= reflected by crystal net plane) wave were obtained, they have been re-written in a form of the so-called Fresnel diffraction with the purpose of having a better understanding of electron microscope images of crystallites. From these formulae, it is concluded that the striations due to "*Pendellösung*" are observed in the just-focused images of crystallites in which Bragg reflection occurs, while in defocused image they are disturbed in the neighbourhood of a crystal edge by the Fresnel diffraction effect. In a special case where the para-

eter indicating the deviation from the Bragg condition is very large, the present formulation applies the phase contrast fringes due to the edge of insparent wedge-shaped substances. The fringes n the vacuum side are expected to be more prominent in the virtual, than in the real, image in accordance with experiment. Some numerical examples of intensity distributions are given for the bright field images of a wedge-shaped crystallite which is out of focus. A.

GEOPHYSICS 55

550.93

327. **Age determinations by the potassium–argon ethod allowing for argon diffusion.** W. GENTNER, . PRÄG AND F. SMITS. *Z. Naturforsch.*, **8a**, 216–17 *Feb.–March*, 1953) *In German.*

Continuing previous work [Abstr. 561 (1951)] on e argon content of tertiary sylvines from Buggingen, was found that the A^{40} content was related to the rystal size. From measurements on samples the ge and diffusion constant in the minerals were alculated to be about 21×10^6 years and $1 \cdot 5 \times 10^{-19}$ m^2/sec respectively. F. R. HOLT

ATMOSPHERE . METEOROLOGY 551.5

551.508.1

328. **Synoptic rocket observations of the upper tmosphere.** S. F. SINGER. *Nature* [*London*], **171**, 108–9 (*June* 20, 1953).

The author suggests the use of small and relatively heap instrument-bearing rockets fired from aircraft t a substantial altitude; by eliminating the aerodynamic resistance of the lower atmosphere, a great ncrease of the peak altitude can be realized, compared with rockets launched from sea level. Precise ocation of the firing point would be possible, and also imultaneous firing of rockets from different points. ome of the investigations possible by this means are isted, and other advantages inherent in the method.

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See bstr.* 6156

551.513

329. **A necessary condition for development of convection in the atmospheric frictional layer near the urface.** E. FRANKENBERGER. Note in *Naturwissenschaften*, **40**, *No.* 5, 162–3 (1953) *In German.*

Convection and frictional turbulence differ in the spatial distribution of concentration of water vapour. Convection can occur only with heated ascending air where there is no wind shear. Calder's equation for the balance of turbulent energy is used to derive an expression for the interchange conditions. The probability of the occurrence of convection from the surface is thus shown to increase with the flow of heat and with a decrease of wind speed. Inserting mean values in this equation an empirical value is found for grass land at Quickborn (Holstein) and the necessary condition for convection is $< v^4\theta' L^{-2} \leqslant 13 \times 10^{11} \pm 50\%$ [cm.$^{-1}$ degrees sec.$^{-2}$ cal^{-2}] where v is the wind speed at a height of 10 m, θ' the vertical gradient of potential temperature and L the vertical heat flow. In agreement with this limiting condition is the rule that the vertical profile of temperature at greater heights can include a very great increase of vertical interchange. R. S. READ

551.578.1 : 551.501.8

6330. **Radar observations of rain at Sydney, New South Wales.** G. A. DAY. *Austral. J. Phys.*, **6**, 229–39 (*June*, 1953).

The radar echoes received from rain during systematic observations carried out from January 1950 to January 1951 at the Radiophysics Laboratory, Sydney, N.S.W., are illustrated and described. Examples of echoes from melting and upper bands, non-freezing and frontal showers, thunderstorms and echo masses are shown by vertical cross-sections of the atmosphere through the point of observation. Correlation between the rain echo and the prevailing weather situation shows that the melting-band rain, which over this period was responsible for most of the rainfall, is usually associated with low pressure, whereas non-freezing showers are shown to be more frequently associated with high pressure. A.

551.583

6331. **Climatic change in Australia since 1880.** E. L. DEACON. *Austral. J. Phys.*, **6**, 209–18 (*June*, 1953).

Australian climatic data show that, for the period 1911–1950, the summer rainfall over much of the southern part of the continent was considerably greater than in the previous 30 years and, for the same season, mean daily maximum temperatures in the interior were appreciably lower. A difference in character of the annual variation at atmospheric pressure between these periods also suggests a shift of mean position of the subtropical high pressure belt. It is tentatively concluded that, contemporaneous with the increased meridional interchange which has taken place over large parts of the northern hemisphere, a similar increase has occurred in the Australian region. A.

551.593.5

6332. **Atmospheric attenuation at Khartoum, Sudan.** C. J. BECK, D. J. LOVELL AND E. O. HULBURT. Letter in *J. Opt. Soc. Amer.*, **43**, 405–6 (*May*, 1953).

Describes observations made in February 1952 in connection with the solar eclipse. Observations extended over 10 days and the photopic attenuation was determined with the aid of a Macbeth illuminator for several altitudes of the sun; for various wavelengths spectroscopic data was used. Values of photopic attenuation obtained varied between 0·147

and 0·288 for the entire atmosphere; difficulties were encountered due to the existence of aureole.

J. M. HOUGH

551.593.9

6333. OH in the airglow at high latitudes. J. W. CHAMBERLAIN AND N. J. OLIVER. Letter in *Phys. Rev.*, **90**, 1118 (*June* 15, 1953).

Microphotometer records of night-sky spectra photographed in green, red and infrared regions with a 15 000 lines/in. grating spectrograph and *f*0·8, 5 in. Schmidt camera at Thule, Greenland, Nov., 1952, reveal the 0–3, 5–0 and 8–2 OH bands. The *Q* branch of the last-named band blends with Na *D*-lines. Rel. intensities of rotational bands, free from overlap distortion, indicate temperatures of atmosphere between 300° and 350°K, i.e. somewhat higher than those determined at intermediate latitudes.

D. R. BARBER

551.593.9 : 535.338.4

6334. Active nitrogen, airglow. O. OLDENBERG. *Phys. Rev.*, **90**, 727–30 (*June* 1, 1953).

The theory of the "Lewis–Rayleigh afterglow" of nitrogen, originally given by Cario and Kaplan, is modified by taking into account recent work regarding resonance in collision processes and the value of the energy of dissociation of N_2, accepted in this paper as 9·76 eV. Kaplan's "auroral afterglow," in which the spectrum of N_2^+ is observed, is tentatively explained by ionization caused by collisions of two metastable molecules. The results are applied to the airglow. A.

551.59

6335. The southern auroral zone as defined by position of homogeneous arcs. F. JACKA. *Aust. J. Phys.*, **6**, 219–28 (*June*, 1953).

Observations on homogeneous arcs (H.A.) ma at Macquarie Island (geomagnetic coordina 60·7° S., 243·1° E) are examined. The latitude H.A. is found to be significantly dependent on t geomagnetic planetary disturbance index K_p and t time of day. For given values of K_p and time t probability distribution of latitude of H.A. has sharply defined mode about 0·5° north of the mean

551.596

6336. Abnormal sound propagation over the sout western United States. C. T. JOHNSON AND F. L HALE. *J. Acoust. Soc. Amer.*, **25**, 642–50 (*July*, 1953

Abnormal propagation of sound in the east-to-we and west-to-east directions has been studied through out a period of a year. Experiments were carrie out over the California–Arizona desert using explo sions of 1200 pounds of TNT. Returns of soun from altitudes of 30 to 50 km were consistentl received to the east in winter and to the west i summer. Sounds which travelled to the high tem perature region at 80 to 100 km altitude were receive about one-fifth of the time. Sounds were returne from the second region somewhat better to the east i summer and to the west in winter. An early arrivin abnormal wave was received at ranges greater tha 400 km.

BIOLOGY 57/59

591.121.08

6337. Modification of the Scholander plastic semi-microrespirometer for use with larger animals. R. J. HOCK. *Rev. sci. Instrum.*, **24**, 455–7 (*June*, 1953).

The purpose of this modification is to allow animals the size of small vertebrates to be studied. The principle of operation is exactly the same, but the changes in construction as described make for wider applicability of the original instrument. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.843.6

6338. The disappearance of steadily fixated visual test objects. L. A. RIGGS, F. RATLIFF, J. C. CORNSWEET AND T. N. CORNSWEET. *J. Opt. Soc. Amer.*, **43**, 495–501 (*June*, 1953).

A system has been devised for causing an image to remain at one point on the retina regardless of eye movements. A beam of light, reflected from a plane mirror on a contact lens, is used to project on to a screen an image of a dark line against a bright background. The screen is viewed by the same eye through an optical system which compensates for the doubling of the angle of rotation of the beam projected from the mirror on the contact lens. Thus, any motion of the eye causes a deviation of the beam such that the retinal image of the projected line undergoes the same displacement as do the retinal receptor cells. By comparison with normal viewing of the same test objects it is found that (1) when first presented, the finest lines are seen with normal or slightly better than normal acuity, (2) within a few seconds the lines begin to disappear, and (3) within one minute even coarse lines are seen only intermittently. The results may be interpreted in terms of local retinal adaptation to a stationary field. A

612.843.61

6339. The facilitative effect of red light on dark adaptation. S. W. SMITH AND F. L. DIMMICK. Letter in *J. Opt. Soc. Amer.*, **43**, 541 (*June*, 1953).

Extra-foveal dark-adaptation limens were measured in 8 trained observers after an hour's controlled light history composed as follows: (1) 30 minutes in normal [white?] lighting (20–25 fL); (2) 10 minutes of white screen (130 fL); (3) 10 minutes of 0·006 fL of red light *or* 10 minutes of darkness; (4) 10 minutes of darkness. No significant difference, due to the alternatives in (3), could be detected. R. A. WEALE

612.843.62

6340. Studies in physiological optics. V. N GÜNTHER. *Optik*, **10**, *No.* 4, 216–18 (1953) *In German.*

For Pt IV, see Abstr. 5260 (1953). The constants

ed in the three equations previously solved are dis-ssed, and numerical values, culled from earlier ork, presented. Of these, E_1 is identified with the ar point of distinct vision, and E_2 the least distance r convergence (33·75 and 15·8 cm respectively). o meaning is ascribed to the other values.

R. A. WEALE

612.85 : 534.32

341. The information of elementary auditory displays. II. I. POLLACK. *J. Acoust. Soc. Amer.*, **25**, 765–9 (*July*, 1953).

For Pt I, see Abstr. 1312 (1953). Previous studies have shown that the amount of information transmitted with a simple one-dimensional auditory display is relatively small. This paper considers three conditions designed to increase the information transmission with elementary auditory displays. The three conditions or variables were (1) the frequency range of tones investigated; (2) the utilization of objective reference tones presented with the unknown tone; and (3) the "dimensionality" of the display—the number of independently varying stimulus aspects of the display. Little additional gain in information transmission is associated with the first factor; a moderate gain is associated with the second; and a relatively substantial gain is associated with the third.

A.

612.858

6342. Review of recent mathematical theories of cochlear dynamics. J. ZWISLOCKI. *J. Acoust. Soc. Amer.*, **25**, 743–51 (*July*, 1953).

An analysis of several theories of cochlear mechanics has been attempted on the basis of general hydrodynamic theory. The theories are divided into two classes according to the mathematical treatment. The first class assumes that transverse waves propagated along the cochlea are long in comparison to the cross-sectional dimension of the canal: all theories of this class can be deduced from one differential equation when the emphasis is put on different factors. The second class assumes that the waves are relatively not long, and the mathematical treatment becomes a boundary problem to which no exact solution has yet been found. The analysis of the individual theories indicates a certain convergence of opinions, and it is clear that definite progress has been achieved toward an understanding of the dynamic behaviour of the cochlea. In spite of this trend, however, no one of the theories seems entirely satisfactory.

A.

612.858

6343. Acoustic attenuation between the ears. J. ZWISLOCKI. *J. Acoust. Soc. Amer.*, **25**, 752–9 (*July*, 1953).

In an investigation of the acoustical insulation between the ears, various earphones and obturating devices were used. Bone conduction was shown to be chiefly responsible for the acoustical leakage between the ears. Conditions were determined under which interaural insulation could be increased considerably. Most of the measurements were performed with a compensation method which appears to give more precise results than methods previously used, and which permits phase measurements.

A.

612.858

6344. Patterns of cochlear adaptation at three frequency regions. J. D. HARRIS AND A. I. RAWNSLEY. *J. Acoust. Soc. Amer.*, **25**, 760–4 (*July*, 1953).

Auditory adaptation was determined in four observers to 100-, 1000- and 4000- c/s tones at 30-, 50-, 70- and 90 db loudness level. The spread of effect to closely adjacent frequencies was particularly examined. The method of adaptation was used to avoid the intrusion of beats in the simultaneous masking experiment. Loudness patterns were drawn according to the method of Munson and Gardner, confirming and extending the earlier study. Within the region represented by the differential threshold, no especial peaking of the loudness pattern was found. For example, at 1000 c/s, there was a broad peak of ± 10 c/s. From earlier experiments, adaptation is thought to be confined to the peripheral sense organ. According to this view, the present data would represent a stage in the process of handling frequency information, intermediate between the much broader amplitude patterns and the more precise operations at the command of the nervous system.

A.

612.858

6345. Description of some mechanical properties of the organ of Corti. G. v. BÉKÉSY. *J. Acoust. Soc. Amer.*, **25**, 770–85 (*July*, 1953).

A short historical introduction is followed by a description of the technique for observing the organ of Corti in a lightly anæsthetized guinea pig with the help of a slit lamp. The magnification was around 200 times, and stroboscopic illumination was used with a 1-kilowatt high pressure mercury-arc lamp. The relative stiffness of the Reissner's membrane, the tectorial membrane, the reticular membrane, and the Hensen cells were investigated with test needles. It was possible to demonstrate the earlier anatomical concepts of the stiffness of the reticular membrane and the pillars of Corti. In order to obtain the high sensitivity of the ear, the stiff tissues of the organ of Corti must be mechanically matched (impedance matched) to vibrating energy of the perilymph. It was found that the organ of Corti is very well suited to work as a transformer for shearing forces. The difference between the vibration pattern of a series of resonators in the sense described by Helmholtz and the pattern of travelling waves is described. The actual observation of the membranes in the organ of Corti showed only travelling waves during stimulation with a pure tone. For every given frequency there was one point along the basilar membrane where a transition in the vibration pattern occurred, and the more radial vibrations of the organ of Corti near the stapes went over into longitudinal vibrations on the wave front facing the helicotrema. The place of transition moves with the frequency of the stimulus. Finally, the different travelling waves which may run along an elastic pad like the organ of Corti are described, and their possible roles in the cochlea are discussed. This leads to some possible explanations of why the cochlea is coiled.

A.

612.858

6346. Shearing microphonics produced by vibrations near the inner and outer hair cells. G. v. BÉKÉSY. *J. Acoust. Soc. Amer.*, **25**, 786–90 (*July*, 1953).

It is possible to show that a laterally vibrating needle placed on the tectorial membrane produces microphonics. The size of these microphonics changes according to the direction of the lateral movements and the place on the tectorial membrane. On the outer edge of the tectorial membrane the microphonics went through a maximum when the direction of the vibrations lay in the direction of the fibres of the tectorial membrane. Perpendicular to this direction the microphonics went through a minimum. On the inner edge of the tectorial membrane the whole direction pattern is turned around counterclockwise somewhat less than 90 degrees. There are two sets of microphonic generators very close to the inner and outer hair cells. The inner set is more sensitive to lack of oxygen. These two sets may be able to discriminate between the radial and longitudinal vibrations of the organ of Corti, a change that occurs near the place of maximal stimulation in the cochlea exposed to a tone. A.

614.

6347. Contribution on the problem of protec agents against radiation. K. ERDMANN. Note *Naturwissenschaften*, **40**, *No.* 4, 147 (1953) *In Germ*

Experiments with muscle eggs show "protectic is given by a sodium salt of thioglycolic acid, thou not by the acid alone. F. T. FARM

615.84

6348. Contribution to the dosage determination β radiation from radioactive substances. K. SOMMI MEYER. *Strahlentherapie*, **88**, 329–44 (1952) *German.*

After incorporation into the body of substanc emitting β-rays, the therapeutic and diagnost problem often arises of estimating the biologic effect of the β-rays in the body at a given distributi of the β-emitters. This biological effect depends c the dose and the specific ionization produced in eac point inside the body. At a known distribution of th β-emitters, the dose and the specific ionization ca be computed without too much trouble from measur ments of ionization of the air by β-emitters. Th author also describes a simple ionization method fc determining the activity of radioactive solutions.

NUCLEAR SCIENCE ABSTRACT

TECHNICAL MATERIALS 66/67

666.22 : 535.345 : 535.323

Optical characteristics of a 980 : 222 glass. *See Abstr.* 5940

PHOTOGRAPHY 77

771.351

6349. Photoelectric contrast measurements on photographic objectives. J. EULER AND G. ZICKWOLFF. *Optik*, **10**, *No.* 4, 206–15 (1953) *In German.*

The objective produces a reduced image of a test object. By means of a photocell arrangement and a slit scanning the image periodically, the contrast values obtained are displayed on a c.r. tube. A range of 1 : 575 is possible with the equipment described. The importance of surface blooming and the effect of stray light from the iris diaphragm are discussed. Some results are given for the non-axial region. S. T. HENDERSON

771.376 : 778.33

6350. The automatic control of exposure time of radiographs by using photoelectric cells. M. MARÉCHAL. *Bull. Sci. Assoc. Ingén. Montefiore* [*A.I.M.*] **66**, 145–55 (*Feb.*, 1953) *In French.*

The amount by which a film exposed to X-rays is affected $\propto V^5iT$. With the voltage and current pre-set the result depends on the exposure time T. The correct value is difficult to determine because of the nature of the intervening subject being photographed. A method of automatic exposure is described in which a portion of the rays after passing through the subject is deflected on to a 9-grid photoelectric multiplier. The charge building up on the 9th grid is a measure of the integrated X-ray intensity falling on the photographic plate, and is arranged to fire a thyratron when it reaches a pre-arranged value, to close the camera shutter. B. B. AUSTIN

771.53

6351. On the mode of action of desensitizers. IX. A. HAUTOT AND H. SAUVENIER. *Bull. Soc. Roy. Sci. Liège*, **21**, 514–30 (*Dec.*, 1952) *In French.*

For Pt VIII see Abstr. 5266 (1953). A general discussion of the preceding 8 articles. No general theory of the action of desensitizers is possible in view of the variable behaviour observed with different desensitizers and different emulsions. The differential absorption of desensitizers on the grains is a likely cause of the variations. S. T. HENDERSON

771.53

6352. Remarks on the Schwarzschild effect. J. EGGERT. *Z. angew. Phys.*, **4**, *No.* 12, 445–7 (1952) *In German.*

A discussion of the relation between two methods of representing the Schwarzschild effect. For each value of the photographic blackening S, a curve may be drawn between log i (ordinate) and log t. In

re recent work the curves are between log *it* dinate) and log *i*, and the effect is called reciprocity- failure. Derivation of p in $S = f(i \times t^p)$ is cribed, and families of curves shown for different es of emulsion. S. T. HENDERSON

771.53

53. On the determination of the light-sensitivity negative material for picture-making exposures. HILTPOLD. *Z. wiss. Photogr.*, **47**, *No.* 10–12, 9–246 (1952) *In German.*

An investigation of the relation between laboratory nsitometry and practical sensitivity as determined the min. exposure required to give a good positive int. Six types of 6×9 cm film and 6 of 24×36 mm re used, with 3 different developers and some her checks by commercial development. The oratory methods for comparison were the German ndard DIN 4512 (1934), a proposed modification this ("neo-DIN"), and the American ASA standard 947). Prints or enlargements were made from each gative on the full contrast range of papers to ensure at the most suitable was included, and 18 observers dependently chose the best print for each negative. athematical treatment of the results showed the IN and neo-DIN methods to correlate well with int assessment. Although the ASA method peared to show larger variations, these were not atistically significant, and there was in fact good rrelation between the DIN and ASA methods.

S. T. HENDERSON

771.53

354. The observation of polyhedral sub-structures crystals of silver bromide. J. M. HEDGES AND J. W. ITCHELL. Letter in *Phil. Mag.*, **44**, 223–4 (*Feb.*, 1953).

Sheets of AgBr made from the molten salt were nnealed in Br vapour, then exposed to radiation at ne long wavelength edge of the absorption band. g particles were produced by printing out, lying long the boundaries of polyhedral units in the large ingle crystals. It is considered that the patterns of g reveal the lines of dislocation produced by strain.

S. T. HENDERSON

771.53

355. The mechanism of desensitization caused by ressure on photographic emulsions. P. FAELENS. *C.R. Acad. Sci.* [*Paris*] **236**, 1348–50 (*March* 30, 1953) *In French.*

The superficial image developed in an emulsion previously submitted to a high pressure is generally ess than normal, unless a very low light intensity is used, in which case a sensitization is observed. The desensitizing effect is decreased by maintenance at 70–110°C for some hours. The effects may be explained by the migration towards the surface of crystal dislocations produced by pressure. S. T. HENDERSON

771.53

6356. Contribution to the development of a new photographic recording process with immediately visible and lasting traces. H. STABE. *Z. wiss. Photogr.*, **48**, *No.* 1–3, 19–44 (1953) *In German.*

Visible traces are produced on a moving band of photographic paper by the image of a point source high pressure mercury arc when the exposure is of the order of 10^7 lux sec. A study was made of the blackening in several emulsions *vs.* the writing speed, also of the large increases in blackening caused by a second exposure of the traces to illumination of ~1000 lux for varying times. The second exposure time (usually mins) may be chosen to render visible previously invisible traces made at high writing speeds, or in other cases to increase the overall contrast. Some results on spectral sensitivity of emulsions are given, and a description of the micro reflex densitometer used. S. T. HENDERSON

771.53

6357. On a practical application of the Clayden effect. E. WEYDE. *Z. wiss. Photogr.*, **48**, *No.* 1–3, 45–7 (1953) *In German.*

After short exposure to very high light intensities, photographic emulsions vary in their reaction to subsequent illumination at lower intensities without normal development. The visible or invisible image of the first exposure may become darker, lighter, or of a different colour from the background. The first of these effects, used by Stabe (preceding abstract), is shown by Agfa type L paper, which has a coarse grained emulsion containing thiourea. The original image may also be developed chemically, or restored if the background has been darkened by long illumination. S. T. HENDERSON

771.53

6358. The Sabattier effect. VI. H. ARENS. *Z. wiss. Photogr.*, **48**, *No.* 1–3, 48–52 (1953) *In German.*

For Pt V see Abstr. 3185 (1952). The second exposure which produces the Sabattier effect may be replaced by the action of many basic inorganic and organic N compounds and other reducing agents. These will produce the positive effect if used in alkaline solution, or they may be added to normal developers. S. T. HENDERSON

771.53

6359. The characteristics of ultraviolet-sensitized photographic plates in the vacuum ultraviolet. PO LEE AND G. L. WEISSLER. *J. Opt. Soc. Amer.*, **43**, 512–15 (*June*, 1953).

The *D v.* log *t* curves of Eastman 103a–O u.v.-sensitized plates have been studied in the near ultraviolet and vacuum ultraviolet, respectively, together with the absorption and fluorescence spectrum of the sensitization lacquer. It was found that the contrast γ_I, obtained from the *D v.* log *t* curves calibrated in the vacuum spectrograph, was a constant within an experimental deviation of 4% throughout all observed wavelengths from 1320 Å to 360 Å and was equal to the contrast of the emulsion at the wavelength of maximum intensity of fluorescence of this lacquer. Numerous methods for the calibration of plates in air have been suggested and one of them was tested in detail. The reciprocity law of these u.v.-sensitized plates was studied and suggestions are made on the procedures leading to correct calibration curves of commercial plates for the purpose of photographic photometry in the vacuum ultraviolet. A.

771.53 : 537.533.73

6360. The calibration of photographic emulsions for electron diffraction investigations. L. S. BARTELL AND L. O. BROCKWAY. *J. appl. Phys.*, **24**, 656–7 (*May*, 1953).

A procedure has been devised which measures the deviation from linearity of the curve relating electron exposure to optical density. The experimental applica-

tion of this procedure is found to give results consistent with a very simple model of the exposure process. It is also noted that the sensitivity of a photographic plate increases with increasing distance from the centre of the plate. Measurements of this effect are given. A.

771.534.5

6361. The determination of photographic film exposure by neutron activation of Ag^{107}. I. B. BERLMAN, H. F. LUCAS AND H. A. MAY. Note in *Rev. sci. Instrum.*, **24**, 396–7 (*May*, 1953).

Densitometry of films blackened by γ-radiation is limited to a density $\sim$6, or $\sim$12 if both sides of a double emulsion film are separately measured. Alternatively, the Ag deposit may be activated under defined conditions by thermal neutrons to produce Ag^{108}, and from counts subsequently given by a β-proportional counter, the original exposure to radiation may be determined. At low exposures this method agrees well with densitometry, and it may also be operated at much higher values of Ag density. S. T. HENDERSON

771.534.55

6362. Spectral distribution of light scattered by photographic layers and the influence of sensitization on resolving power. I. I. BREĬDO AND P. KH. PRUSS. *Zh. tekh. Fiz.*, **22**, *No.* 3, 515–24 (1952) *In Russian.*

The distribution depends on the size of the emulsion particles which is related to the wavelength scattered. Sensitization, by affecting the particle size may vary the wavelength scattered and thus affect the resolving power. W. BARDSLEY

778.3 : 537.542

Gray wedge pulse-height analysis. *See Abstr.* 6113

778.33

6363. An improved method of contact radiography. J. RASCH. *Experientia*, **9**, *No.* 4, 149 (1953) *In German.*

A brief report is given on the use of collodion emulsions in automicroradiograph technique. It would be possible to apply it to physiological and metallographical problems. A.

778.34

6364. A study of tracks with small multiple scattering and minimum ionization occurring in nuclear emulsions. T. MIKUMO AND M. MAITROT. *J. Phys. Radium*, **13**, 609–18 (*Dec.*, 1952) *In French.*

778.34

6365. The use of stripped emulsions for recording the tracks of charged particles. C. F. POWELL. Letter in *Phil. Mag.*, **44**, 219–22 (*Feb.*, 1953).

Technical advances are described which have enabled thick stripped emulsions to be processed and mounted for microscopic examination without distortion. The advantages to be gained from applying the method widely in nuclear physics are pointed out. J. J. WILKINS

778.34

6366. The use of photographic emulsions for the detection and study of nuclear phenomena. History, results and possibilities. Bibliography. L. VIGNERON. *J. Phys. Radium*, **14**, 121–7 (*Feb.*, 1953) *In French.*

778.34

6367. Grain density in nuclear emulsions. L. M. BROWN. *Phys. Rev.*, **90**, 95–7 (*April* 1, 1953).

A simple model of a nuclear track emulsion is discussed in which it is assumed that a grain is m developable only if a charged particle loses in grain an energy greater than some threshold valu It is estimated that a particle of minimum ioniza loses, on the average, an energy of order of magniti η in traversing the diameter of a grain and, theref that fluctuations in the energy loss are import This has as a consequence that the shape of the cu of grain density v. energy and, in particular, percentage relativistic increase of grain density m be sensitive to small variations of η.

778.34 : 77.02

6368. Treatment of nuclear emulsions from 100 1000 μ thick. G. MARGUIN. *J. Phys. Radium*, 43–6 (*Jan.*, 1953) *In French.*

Description of techniques (using i.r. temperatu development) giving uniform development in dep and reduced distortion. W. J. SWIATEC

778.34 : 771.5

6369. The fading of the latent image due to charg particles. P. DEMERS, J. LAPALME AND J. THOUVENI *Canad. J. Phys.*, **31**, 295–328 (*Feb.*, 1953) *In French*

The fading of the latent image due to α-particl and to protons shows similar characteristics in ni types of nuclear track emulsions. Oxygen is almo without effect on the rate of fading, the humidity the dominant factor. At low temperatures late image fading is completely eliminated. The grai density of a particle track is found to be an exponenti function of the nth power of the time interval betwee exposure and development, n varying between 0 and 2·0. The track grain density is also a linea function of the initial density with time-dependen coefficients. For extreme fading the grain density o the tracks still visible is independent of the ionizin power of the particle. A mechanism of latent imag fading, analogous to that of the Herschel effect, i proposed, based on the thermal ejection of an electron from the latent image speck. A. C. COATES

778.35

6370. Air photography. D. E. MACDONALD. *J. Opt. Soc. Amer.*, **43**, 290–8 (*April*, 1953).

Common uses of air photography are considered. As it is employed, it serves as a simple communication system. This concept provides a basis for evaluation of system performance. A survey of recent contributions is presented in order to establish these performance criteria. A.

778.37

6371. The multiple spark camera and its use in technical physics. H. SCHARDIN. *Z. angew. Phys.*, **5**, *No.* 1, 19–24 (1953) *In German.*

Rapid events may be photographed by a series of sparks separated in space so as to produce separate images on the film, and also spaced in time to give the required frequency ($\sim 10^5$ per sec). Circuits and optical arrangements are figured, and photographs of elastic waves in a glass plate reproduced. By the use of one spark reflected repeatedly between two mirrors it is possible to make use of the transit time of the light and raise the picture frequency to 10^7 per sec or higher. Possible applications are discussed briefly. S. T. HENDERSON